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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 698

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. PROFESSIONAL PAPER October 31, 1918

GRAIN-SORGHUM EXPERIMENTS IN THE PANHANDLE OF TEXAS

By

CARLETON R. BALL, Cerealist in Charge, and BENTON E. ROTHGEB, Scientific Assistant in Charge of Grain-Sorghum and Broom-Corn Investigations, Office of Cereal Investigations

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INTRODUCTION.

The agricultural development of the district known as the Panhandle of Texas is an interesting study. It is the story of four successive stages—free range, fenced range, attempts at grain farming, and finally mixed farming. In this last stage stock raising is again the basis, and the chief crops are those that furnish feed. Chief of all such crops are the sorghums, especially the grain-producing varieties.

The whole history of the grain sorghums has been a history of their ecology. Any experimental study of these crops must be a study of their response to environing conditions. The southern half of the Great Plains area, which properly may be called the grain-sorghum belt, is a section where crop production is governed almost entirely by the quantity and distribution of the annual precipitation.

The sorghums are able to produce under conditions of less moisture and its more uneven distribution than are other crops; hence their extensive use. An understanding of how the different groups and varieties respond to the varying seasonal conditions is necessary to a further increase in their usefulness. To show this response, it is necessary to present climatic data much more completely than is

usual in bulletins of this kind; hence the large space allotted to such data and their discussion in the present bulletin. It accounts also for the inclusion in the tables of more agronomic data than often is given in a presentation of the results of varietal experiments.

The Office of Cereal Investigations began its experiments with these crops in the Panhandle in 1904. These experiments were conducted for three years at Channing, Tex., on the X I T Ranch. In 1906, work was begun at Amarillo, Tex., where it is still in progress. Plat experiments were first developed on a large scale in 1908. This bulletin presents the results obtained in the 9-year period from 1908 to 1916, inclusive.

The experimental data include only the results of varietal experiments. A report of the experiments on spacing or rate of seeding and on date of seeding will be reserved for later publication. Among the agronomic data shown are the row space per plant and per stalk, the duration of the various stages of the growing period, the production of suckers, the percentage of erect heads in the milos, the height of the plants, and the yield in bushels per acre. For certain varieties and in certain years there are shown also the percentages, by weight, of heads in the total crop and of seed in the total crop and in the heads.

The data obtained have been used as a basis for the statements made in numerous popular and scientific publications,[1] in which, however, none of the detailed plat data were published. A brief summary of the experimental results was given by Ross and Leidigh in the bulletin cited.

THE PANHANDLE.

LOCATION.

The Panhandle strictly is that part of northwestern Texas which extends northward from the main body of the State. In common practice, however, this term is applied to a much larger portion of

[1] Ball, C. R. Three much-misrepresented sorghums. U. S. Dept. Agr., Bur. Plant Indus. Cir. 50, 14 p., 2 fig. 1910.

——— Better grain-sorghum crops. U. S. Dept. Agr., Farmers' Bul. 448, 36 p., 13 fig. 1911.

——— The importance and improvement of the grain sorghums. U. S. Dept. Agr., Bur. Plant Indus. Bul. 203, 45 p., 13 fig. 1911.

——— The kaoliangs: A new group of grain sorghums. U. S. Dept. Agr., Bur. Plant Indus. Bul. 253, 64 p., 15 fig., 1 pl. 1913.

——— The grain sorghums: Immigrant crops that have made good. U. S. Dept. Agr. Yearbook for 1913, p. 221–238, fig. 5–12, pl. 29–35. 1914.

——— and Leidigh, A. H. Milo as a dry-land grain crop. U. S. Dept. Agr., Farmers' Bul. 322, 23 p., 9 fig. 1908.

——— and Rothgeb, B. E. Kafir as a grain crop. U. S. Dept. Agr., Farmers' Bul. 552, 19 p., 8 fig. 1913.

Ross, J. F. Cereal crops in the Panhandle of Texas. U. S. Dept. Agr., Farmers' Bul. 738, 16 p., 5 fig. 1916.

——— and Leidigh, A. H. Cereal experiments in the Texas Panhandle. U. S. Dept. Agr., Bur. Plant Indus. Bul. 283, 79 p., 13 fig. 1913.

Rothgeb, B. E. Shallu, or "Egyptian wheat": A late-maturing variety of sorghum. U. S. Dept. Agr., Farmers' Bul. 827, 8 p., 2 fig. 1917.

Vinall, H. N., and Ball, C. R. Feterita, a new variety of sorghum. *In* U. S. Dept. Agr., Bur. Plant Indus. Cir. 122, p. 25–32. 1913.

western Texas, including the so-called "Staked Plains." The word is here used in the broader sense. Figure 1 is a sketch map of this district. No definite eastern or southern boundary for the Panhandle has ever been fixed. The eastern boundary is generally held

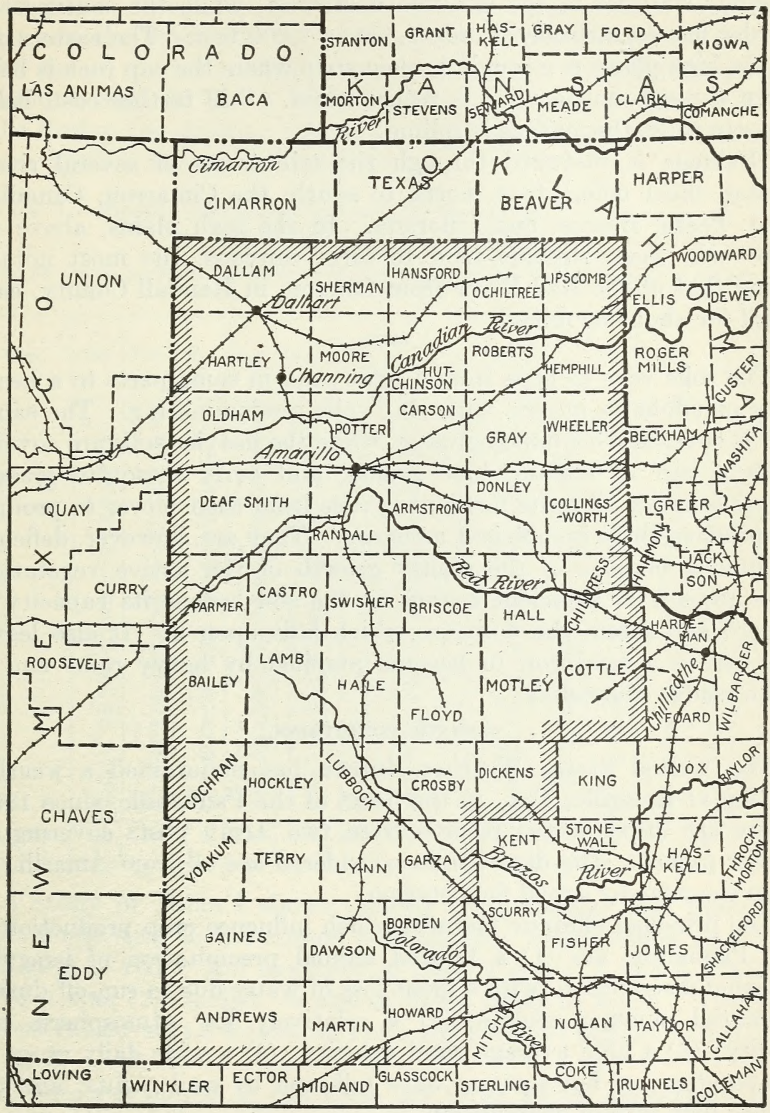

FIG. 1.—Sketch map of the Panhandle section of Texas and the surrounding country. The Panhandle section as discussed in this bu lletin is indicated by the shaded boundary.

to be the escarpment locally known as the "cap rock," which roughly approximates the line of the 2,000-foot contour. The results given herein are applicable to all this district, including small portions of adjacent New Mexico and Oklahoma.

ALTITUDE AND DRAINAGE.

Most of this district is a high and nearly level table-land with an average altitude of about 4,000 feet and with a rather uniform slope to the east and southeast. The highest elevation reached is about 4,800 feet in the extreme northwest, while the southeastern border has an altitude of only 1,500 to 2,000 feet. The eastern rim of the high plains is a rough, broken strip where the cap rock is being worn through and erosion is rather rapid. Still farther east, below the cap rock, the surface is rolling.

Drainage is eastward through the tributaries of several rivers, among them being, from north to south, the Cimarron, Canadian, Red, Pease, Brazos, and Colorado. In the high plains, above the cap rock, these streams tend to form canyons, the most notable being that of the Red River from Canyon, in Randall County, eastward for about 60 miles.

SOIL.

The soils vary in type from a light sand in some parts to a heavy clay or adobe in others, with clay soils predominating. The sandy soil is covered with bunch grasses, while the heavier soils are covered with a turf of buffalo, blue grama, and curly mesquite grasses. These soils are all quite fertile, to judge from their power to produce crops when there is sufficient moisture. They are, however, deficient in humus because of the scanty growth of the native vegetation. The absence of sufficient humus in the soil lessens its capacity to absorb and retain the moisture which falls upon it. It also leaves the soil in a condition to become puddled by heavy rains and to bake readily thereafter.

CLIMATIC CONDITIONS.

The United States Weather Bureau has maintained a weather station at Amarillo, Tex., in the heart of the Panhandle, since 1892. There are disconnected records from two Army posts covering an earlier period. The data herein considered are all from Amarillo or from the near-by cereal field station.

The principal climatic features which influence crop production in the Panhandle are (1) a limited annual precipitation of irregular seasonal distribution, with a great loss of water due to run-off during torrential summer storms; (2) a relatively low atmospheric humidity; (3) a high average wind velocity; (4) a wide daily range of temperature, or hot summer days followed by cool nights; and (5) a very high rate of evaporation.

Precipitation.

Moisture is the limiting factor in crop production in most of the Panhandle. Precipitation is the primary and most important factor in the moisture problem.

MONTHLY AND ANNUAL PRECIPITATION.

In Table I are shown the monthly, the annual, and the mean annual precipitation, in inches, at Amarillo, Tex., during the 25-year period from 1892 to 1916, inclusive. The monthly precipitation and the departure from the normal will be found in Table IV. The mean annual precipitation at Amarillo during this 25-year period is seen to be 21 inches, more than three-fourths of which falls during the growing season for grain sorghums, the six months from April to September, inclusive.

TABLE I.—*Monthly and annual precipitation at Amarillo, Tex., during the 25-year period from 1892 to 1916, inclusive.*

[Data (in inches) furnished by the observer of the United States Weather Bureau at Amarillo, Tex. T. = trace.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Mean annual.
1892	0.42	0.57	2.10	0.21	2.70	1.49	1.85	1.93	0.24	2.85	0.16	1.08	15.60	.....
1893	.09	2.03	T.	.16	2.19	2.03	2.05	2.67	5.27	.03	.28	.43	17.23	16.42
1894	.02	1.15	.05	.85	1.30	3.59	1.82	3.41	2.41	.39	.....	.82	15.81	16.21
1895	1.60	1.92	.16	1.31	1.78	6.84	2.88	3.87	.57	2.26	.81	.79	24.79	18.36
1896	.76	.41	.21	1.95	2.20	2.31	7.04	.63	2.45	3.09	.35	2.88	24.28	19.54
1897	2.26	.65	.47	1.08	4.44	2.32	2.16	2.71	.73	1.63	.08	.63	19.16	19.48
1898	.86	.82	.35	.98	3.52	4.81	3.88	4.03	.48	.41	.34	2.06	22.55	19.91
1899	.29	.07	.17	.23	3.12	4.45	6.96	.51	6.09	1.15	3.24	1.11	27.39	20.85
1900	.59	.47	.48	5.47	4.53	1.94	3.21	.83	5.25	1.58	.08	.07	24.40	21.24
1901	.03	.48	.02	4.90	5.99	.82	1.56	3.03	2.19	3.26	2.00	.04	24.42	21.56
1902	.04	T.	.54	1.83	9.14	2.01	1.45	2.42	.95	1.74	2.24	.55	23.11	21.70
1903	.12	2.93	.26	.90	1.79	2.83	3.38	4.67	.82	2.58	.....	T.	20.28	21.58
1904	.16	.08	T.	.63	2.88	5.53	2.48	4.69	3.55	.44	.20	.69	21.33	21.56
1905	1.00	1.52	2.62	4.52	6.16	2.19	3.76	.63	3.08	.30	5.09	1.45	32.32	22.33
1906	.41	.51	.64	3.23	1.18	2.07	2.90	6.76	1.96	2.49	2.58	.19	24.92	22.50
1907	1.11	.24	.02	1.25	.99	1.97	1.49	6.20	.91	1.79	.66	1.46	18.09	22.22
1908	.26	.72	T.	1.90	3.55	1.73	5.40	2.75	1.83	.40	.51	.....	19.05	22.04
1909	.07	.28	1.28	.50	1.08	4.72	3.63	.87	2.19	1.18	3.25	.54	19.59	21.90
1910	.05	.17	.34	.59	2.99	.66	3.57	2.19	.05	.26	.28	T.	11.15	21.34
1911	.13	2.88	.50	2.76	5.88	.20	3.85	2.97	.83	.84	.94	.95	22.73	21.41
1912	T.	1.85	.78	.82	1.62	2.31	2.50	1.51	2.28	.33	T.	.33	14.33	21.07
1913	.11	.55	.59	1.76	1.41	2.32	1.80	.61	4.19	.81	1.98	2.84	18.97	20.98
1914	.06	.01	.15	.95	4.43	.84	3.07	2.97	1.07	4.46	T.	1.17	19.18	20.89
1915	.72	1.60	1.00	5.05	1.70	1.04	4.14	5.85	4.69	1.55	.18	.13	27.65	21.18
1916	.36	.02	.57	1.71	.89	2.18	.94	3.82	1.76	2.90	.40	.88	16.43	20.99
Average..	.46	.88	.53	1.82	3.09	2.53	3.11	2.90	2.23	1.55	1.06	.84	20.99	.....

A study of Table I shows, among other things, that there is a wide fluctuation in the annual precipitation, which comes mostly in the form of rain. For example, in 1910 it was 11.1 inches, while in 1905 it was 32.3 inches, or almost three times as much. The next lowest record is 14.3 inches, in 1912, and the next highest 27.7 inches, in 1915.

Interesting figures in the table are those which apparently show periodical recurrence in precipitation. The records begin only in 1892. In the first 3 years the annual precipitation was low, the highest being only 17.2 inches. The mean for these 3 years is only 16.2 inches. Then follows a period of 12 years, 1895 to 1906, inclusive, in which the annual precipitation is high. In this period it drops below 20 inches but once, in 1897. On the other hand, it once

exceeds 30 inches, in 1905, when the total precipitation was 32.3 inches. The mean annual precipitation in this 12-year period is 24.1 inches. The third and final period covers the 10 years from 1907 to 1916, inclusive. Here, again, the annual precipitation has been comparatively low. Only twice in these years has it exceeded 20 inches. The lowest record is 11.2 inches, in 1910, and the highest 27.7 inches, in 1915. The mean annual precipitation in the period is 18.7 inches. Of course, these records cover far too short a period in which to prove the occurrence of cycles in rainfall or other climatic factors.

DISTRIBUTION OF DAILY AND MONTHLY RAINFALL.

The figures representing the total annual or seasonal precipitation may easily be misleading, especially to a person who is not familiar with this section of the country. This is due to the irregular distribution of summer rainfall in time and extent, to the varying quantities deposited by different showers, and to the manner in which it falls. The nature and distribution of the rainfall will be better understood by a study of the data in Table II, containing the records of daily precipitation, with monthly totals, throughout the 10 years from 1907 to 1916, inclusive. The monthly precipitation and its departure from the normal are summarized in Table IV.

TABLE II.—*Daily and monthly precipitation at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive.*

[Data (in inches) furnished by the observer of the United States Weather Bureau at Amarillo, Tex. T. = trace.]

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907:												
1							0.70	0.03				
2				T.	T.		.03	1.42		0.02		
3		T.				0.32		.14	0.21	.65		
4				0.29				.19				
5				T.								
6					0.02	.05						
7					T.					.05		
8	0.85				T.							
9	T.		T.		.34				.68			
10							.41				0.01	
11											.02	
12	.05					T.	.01					
13					T.							
14					.02	T.	T.					
15							T.					
16	.03						T.					
17	T.					1.27					.01	
18	.05				T.	.09				T.	.05	
19	.01			.04				.41	.02	.03	.57	
20				.28		.24		.07				
21				.48		T.		1.47		.25		
22				.04	.03			2.30				
23					.05							
24	.02					T.				.54		
25	.03						T.			.02		
26	.03						.26					
27		0.24	T.				.04					
28			0.02		.14		.04			.02		
29				.11	.17							
30	.04			.01	.19			.01	T.			
31					.03			.16		.14		
Total	1.11	.24	.02	1.25	.99	1.97	1.49	6.20	.91	1.79	.66	1.46

TABLE II.—*Daily and monthly precipitation at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908:												
1							1.07		0.74			
2	0.02							0.82	.05			
3	.20	0.01										
4		T.		0.01						0.15		
5	T.											
6						0.42	.01					
7				T.		.34	.18					
8			T.									
9				.15		T.						
10		.01										
11		.10		T.				T.			0.01	
12							T.				.04	
13		.12					.10	.77			T.	
14		.48						T.	.23			
15	.04			.62								
16				.09	0.46				.15			
17							.54	T.				
18							.02			T.		
19				1.03			.36			.15		
20								.11				
21								T.				
22					1.81			.48	T.	.10		
23		T.			1.05		T.					
24					T.	.35						
25									.32			
26								.25	.18			
27						T.	1.13	.32	.16		.09	
28						.58					.36	
29			T.	T.			.04				.01	
30			T.		.19	T.	.60					
31							1.35	T.				
Total	.26	.72	T.	1.90	3.55	1.73	5.40	2.75	1.83	.40	.51	0
1909:												
1	T.					T.	1.18					
2	.01					.10						
3							.02	.10				0.01
4		.02					T.	.06	.47			.12
5		.02						.04	.20			
6						T.	.67		T.			T.
7						.20		.32	1.49			
8			0.07	.07	.04	T.	.82	T.		.04		T.
9							.20	.34				
10	T.					.20						
11	.06		.44			.34						
12			.20	T.		.08			.03		.99	
13		T.				.88		T.	T.		.12	
14		T.				.18		T.			T.	T.
15						.01	.01	.01			.24	
16					T.	T.						
17										.92		.36
18		.24							T.	.21		.05
19			T.		.27		T.	T.		.01		T.
20		T.		.18	.60	1.08		T.				
21				.06		.34						
22				.11	.05	T.						T.
23		T.		T.	.03							
24			T.		.03	.31						
25						.65	.10					
26						.25	.63					
27					.05						.57	
28											.98	
29											.35	
30			.03	.30	.01	.01						
31			.54									
Total	.07	.28	1.28	.50	1.08	4.72	3.63	.87	2.19	1.18	3.25	.54
1910:												
1						T.	.21					
2		T.					.01		T.			
3	T.	T.			.57			.67				
4	.03			.10	.31							
5					.02	.01	.05	.02			.27	
6						.02	.07	.18				
7					T.							
8							.32					
9				.22			2.05	.64				
10							.02	.18				

TABLE II.—*Daily and monthly precipitation at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1910—Contd.												
11	0.01								T.	0.02		
12	.01			T.				T.				
13				0.26	0.26	0.02						
14	T.			T.	.03				T.		0.01	T.
15			0.06	.01	.77	T.		T.				
16		0.17	.15					0.19				
17			T.		T.			.01				
18					.17		T.	T.				
19			T.							.06		
20										.18		T.
21					.60							
22					.05	.01			T.			
23		T.			.01							
24						T.		.26	0.05			
25			T.		T.	.07		.02				
26		T.				.25						
27					.20							
28			.13			.28						T.
29												
30					T.							
31							0.84	.02				T.
Total	.05	.07	.34	.59	2.99	.66	3.57	2.19	.05	.26	.28	T.
1911:												
1	.05							.20			.08	
2				T.			.01			.13	.33	
3				T.			T.				T.	
4		T.		.01	T.		.01			T.	T.	
5									T.	T.	.12	
6						T.	.32					
7							.04		T.			
8												
9						.11	.03		.13			0.01
10		.15		T.								
11							.06					
12					T.		.32					
13					.40		.42					.02
14					.15		T.					T.
15	T.				.01				.41			
16		.46					.03					
17	.07	1.61				.08	.50					
18		.22							T.			.04
19		.15					.68		T.			.76
20			.40		.04		.47		.01	.07		.07
21		T.	.10	.04			.49	.07		T.		
22							.12	.66				
23	.01			2.61				2.02				
24				.07								
25				.02		T.						.02
26				.01	.61					.19	.06	T.
27		.03				.01	.16	T.		.17	.35	
28	T.	.26			1.64		.03	.02		.14		
29					2.90		.14			.14		T.
30					.13				.28			.03
31							.02					
Total	.13	2.88	.50	2.76	5.88	.20	3.85	2.97	.83	.84	.94	.95
1912:												
1				.03			.01			.07		
2							T.					
3	T.	T.					.11	.36	T.			
4							T.	.43	.11			
5	T.			.21					.09			
6						.03		.35				.07
7					.17			T.		.01		
8				.08	.06	.18		T.				
9					.46	.19						
10			.15		T.			.32	.24			
11	T.			T.		1.48			1.17			
12					.21	T.			.11			
13		.14			.04				.40			
14					.28				.03			
15		.07		.11					T.			
16				T.			.02		.12			
17	T.			.04		.02	.47		.01			
18				.15								
19						.01				T.		
20		.14	T.				.22	.05				
21												
22						.03						.26

TABLE II.—*Daily and monthly precipitation at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1912—Contd.												
23			0.26			0.29						
24				0.18			T.					
25		1.50			0.40							
26							0.34	T.			T.	
27				.02								
28							.28					
29	T.											
30						.08	.94			0.25		
31			.37		T.		.11				T.	
Total	T.	1.85	.78	.82	1.62	2.31	2.50	1.51	2.28	.33	T.	0.33
1913:												
1	T.						.01					.05
2		.12			.08				T.			.27
3		.06	T.		.01	.01				T.	0.45	.21
4					.67	.44			T.		.27	1.10
5	0.02					T.						.14
6	.03			T.		.05			T.			
7	.06	.22		T.		.32			T.			
8				.03	.11	.09		.17	.35			
9			T.	T.	.49	T.						
10		.03	.02			.06		.17	.77			
11			.03		T.	.03		.09	.68			
12			T.			.76		T.				
13			T.		T.							
14			.06									
15			T.							.10	T.	T.
16									.39	.15	.01	.34
17								T.		.26		
18						.11				.23	T.	
19				T.	T.	.06						T.
20		.06	T.	T.		.16	.05					
21				.13		.19		.05				.67
22		T.		1.14						T.		.06
23				.46			.15		.18			
24		T.					T.		.03			
25			.30		T.		.82	T.	.60		.25	
26			.18				.01	.08	.28	.07		
27		.03			.01		.03		.90			T.
28		.03				.03	.73	.02	.01			
29					.04	T.		.03			.95	
30				T.		.01					.05	
31												
Total	.11	.55	.59	1.76	1.41	2.32	1.80	.61	4.19	.81	1.98	2.84
1914:												
1					.96		.57					
2				.04		.06	.04	.62				
3	T.			.17	T.							
4							.22	.67				
5		T.						.11				
6				.43			.63		.30			
7				.17		.10	.07					
8												
9								.58				
10				.10				.41	.31			
11			T.	.01					.29	.09		
12								T.	.15			
13												
14					.04	.05				T.		
15					.48	.01			.01			
16					.81							
17					.09		.21					
18				.11	.47							
19					.07		.11					
20			.01		T.	.43						.43
21					T.				T.	.15		
22				.01					.04	2.28		
23										1.46		
24												.44
25							.02					
26				.06	T.							
27		.01			.22		.03					
28				T.	.47							
29			.01	.03	.02			.13				
30				.19	T.	T.						
31					.20							
Total	T.	.01	.02	1.27	3.83	.65	1.90	2.52	1.10	3.98	0	.87

TABLE II.—*Daily and monthly precipitation at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive*—Continued.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1915:												
1						0.22	0.02	0.02				
2			0.20	T.		.03	.01					
3			.10				.06					
4			.25			.23	.33					
5					T.	T.	T.		T.			
6			T.	0.25	0.08	T.			T.			0.05
7				.40		.01		T.				
8			.04	.25			T.	.73				
9			.17	.01			.01	.32				
10											T.	
11								T.		0.21		
12							.01			.12		
13							.79					
14				.05				2.89		1.13		
15	T.		T.	.63			.61	.36	0.11	.09		
16	0.29			.30	.39		1.33	.20	.02			
17				1.34	.44			T.	.34		0.18	
18		T.		T.	.01		T.		.04			
19			T.	.03	T.		.21		.11			
20		0.83			.19		.54		T.			
21		T.	T.	.09				.27				
22	.03	T.		.07		T.			.14			
23	.01							.31	.03			
24				.73			.12	.20	.22			T.
25	T.			.28		.40	.02		3.05		T.	
26	T.	.58	T.		.23				.01			
27		.19			.21	.06		T.				.02
28						.09		.55				
29	.01			.55	.11	T.	.08		.05			
30	.12			.07	.04	T.	T.		.57			
31	.26		.24									.06
Total	.72	1.60	1.00	5.05	1.70	1.04	4.14	5.85	4.69	1.55	.18	.13
1916:												
1		.02		T.						T.		
2												
3												
4	T.			.22		1.38						
5						.15						
6				.06		.04			T.			
7				T.				T.				.21
8								.03	.06		.03	.05
9					T.							
10	T.		T.						.51	.70		.04
11	.07				T.		T.		.01	.02	T.	
12		T.		.04		T.	.01		.01	.82	T.	
13				.16		T.		.28		.02	.03	
14			T.	.97		.03		.01		1.07		T.
15					.01	.35						
16	.05					.12		.04		T.		
17	.12				.88			.14				T.
18							.02		.17			
19					T.		.19	.27	.01			
20	.11			.12			T.	.99				.16
21								1.49			.34	.11
22						.11		.41				
23			.17					T.	.70			
24									.29	.04		
25	T.			.02								
26	T.			.12								
27	T.						T.					
28	T.	T.					T.			.23		
29	.01						.72					
30	T.			T.			T.	.16				.20
31			.40					T.				.11
Total	.36	.02	.57	1.71	.89	2.18	.94	3.82	1.76	2.90	.40	.88

In most of the years during which these experiments have been continued the annual precipitation has been sufficient in quantity for the production of good crops of grain sorghums. In several of these years, however, good crops have not been obtained. The varying degrees of failure have been correlated in some measure with

unfavorable distribution of the large and important seasonal rainfall. Figure 2 shows in graphic form the annual and seasonal rainfall (April to September, inclusive) during the 10-year period from 1907 to 1916, inclusive.

Unfavorable distribution may occur in various ways. Much or most of the seasonal rainfall may come near the beginning or toward the end of the growing season. While the total quantity may have been about normal, protracted drought may have occurred during some part of the year. The occurrence of spring droughts in 1907 and 1909 is shown in Table II. In these years no effective rains fell until the middle of June. The same conditions prevailed to a lesser extent in 1913, while the autumn also was unusually dry.

In the second case, a considerable rainfall may come all at the beginning of one month and again at the end of the following month. Several weeks of drought may have intervened between two rainy

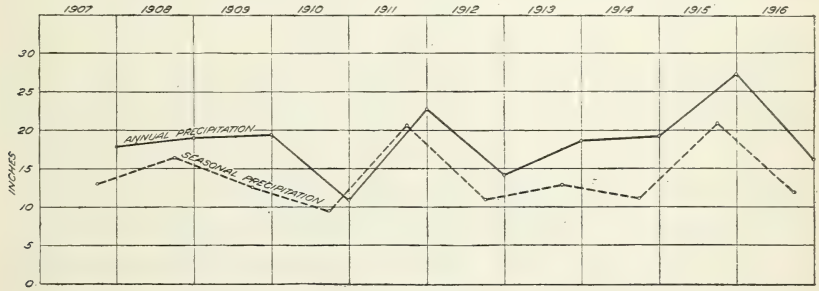

FIG. 2.—Diagram showing the seasonal (April to September) and annual precipitation, in inches, at Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive.

periods, although the total precipitation in each of the two months was about normal. A study of the daily precipitation record of the years 1911, 1912, and 1913 in Table II will illustrate this condition. In 1911 there was no effective rain between July 21 and August 22, though the rainfall in both months was good. In 1912 there was no effective rainfall between June 11 and July 17, and in 1913 from June 12 to July 25, although the total precipitation in each of these months except the last was satisfactory in quantity.

A third condition occurs in which a rainfall may be evenly distributed in point of time and about normal in quantity and yet be deficient for crop production. This is when it occurs in the form of light showers which do not penetrate the soil and are soon evaporated. Several showers of about a quarter inch each may add no water to the soil if followed by drying winds and bright sunshine, which cause rapid evaporation. Such showers are then of little or no value to the growing crop. The months of June, July, and August, 1912, and June, 1913, are examples of this condition, as may be seen in Table II.

LOCAL VARIATION IN PRECIPITATION.

Much of the summer rainfall is derived from storms which are very local in extent. In a single storm period a series of heavy showers may occur at about the same time in the same district but covering different localities and leaving intervening stretches almost unwatered.

The variation in the rainfall at two near-by points is illustrated in Table III. This table compares the rainfall measured at the United States Weather Bureau observatory in the town of Amarillo with that recorded at the Amarillo Cereal Field Station during seven summer months in the years 1909 and 1914. The distance between the two points of observation is about 2½ miles.

TABLE III.—*Comparison of the rainfall, in inches, at the United States Weather Bureau observatory and at the Amarillo Cereal Field Station during the seven months from March to September, inclusive, in 1909 and 1914.*

Station.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Total.
Season of 1909:								
United States Weather Bureau	1.28	0.50	1.08	4.72	3.63	0.87	2.19	14.27
Cereal field station	1.08	.27	1.13	5.90	2.19	1.39	1.90	13.86
Season of 1914:								
United States Weather Bureau	.15	.95	4.43	.84	3.07	2.97	1.07	13.48
Cereal field station	.02	1.27	3.83	.65	1.90	2.52	1.10	11.29

These local rains frequently last but a short time, but are of a torrential nature. This often results in a loss of much water by run-off. Such beating rains also puddle the surface soil and cause much damage in that way.

HUMIDITY.

The atmospheric humidity is low, on the average. This no doubt plays an important part in influencing transpiration from growing crops.

WIND.

Monthly data on wind are shown with other climatic data in Table IV. The average hourly wind velocity in the 10 years from 1907 to 1916, inclusive, is 11.8 miles. During the 4-year period from 1907 to 1910, inclusive, there was an average of 14 days in each year in which a wind velocity of over 40 miles an hour was recorded. The maximum, 63 miles, occurred on March 24, 1909. During the 6-year period from 1911 to 1916, inclusive, the data show merely the maximum hourly velocity recorded during the month and no longer the number of days having high wind velocities. The maximum, 46 miles an hour, occurred in February and April, 1911, and in April, 1915. Such high winds often cause great damage to the crops either by covering up the young plants, by cutting them off by moving particles of soil, or by blowing down the crop when it is almost or quite mature.

TABLE IV.—*Monthly climatic data, covering temperature, precipitation, aspect of sky, and wind movement, recorded at the observatory of the United States Weather Bureau, Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive.*

Year and month.	Temperature (° F.).							Precipitation (inches).			Aspect of sky (days).			Wind.		
	Mean.	Departure from the normal.	Maximum.		Minimum.		Greatest daily range.	Total.	Departure from the normal.	Snowfall unmelted.	Clear.	Partly cloudy.	Cloudy.	Prevailing direction.	Movement.	Velocity of 40 or more miles per hour.[1]
			Reading.	Date.	Reading.	Date.										
															Miles.	*Days*
1907:																
Jan.	52.4	+10.5	74	5	15	25	46	1.11	+0.42	0.9	15	12	4	S.	9,467	0
Feb.	44.2	+ 8.6	74	8	7	3	42	.24	− .63	.6	21	4	3	S.	7,789	1
Mar.	56.8	+11.8	96	19	20	1	46	.02	− .18	0	25	4	2	S.	10,039	2
Apr.	52.6	− 2.0	90	10	23	30	55	1.25	− .45	8.3	18	8	4	S.	10,313	2
May.	59.0	− 5.3	90	17	26	4	40	.99	−2.19	0	20	8	3	NW.	10,260	1
June.	71.6	− .4	104	29	44	1	44	1.97	−1.02	0	21	7	2	S.	9,585	1
July.	76.0	− .1	99	24	55	1	36	1.49	−1.68	0	21	9	1	S.	9,606	2
Aug.	76.3	+ 1.7	97	15	58	31	35	6.20	+3.39	0	16	11	4	S.	9,019	1
Sept.	70.8	+ 3.1	91	7	42	28	38	.91	−1.45	0	17	13	0	S.	8,503	1
Oct.	57.6	+ 1.5	86	2	35	8	57	1.79	+ .80	0	10	12	9	S.	8,196	1
Nov.	43.3	− .5	74	6	16	12	38	.66	− .50	4.0	14	9	7	S.	6,725	0
Dec.	38.3	.....	71	1	12	18	37	1.46	.....	1.4	15	11	5	S.	9,773	1
1908:																
Jan.	38.8	+ 4.9	70	9	7	16	44	.26	− .35	.4	18	10	3	S.	10,222	2
Feb.	40.4	+ 3.2	77	28	4	1	43	.72	− .20	6.0	17	10	2	NW.	9,318	4
Mar.	52.2	+ 7.2	86	17	20	9	48	T.	− .65	T.	23	6	2	S.	9,363	2
Apr.	55.7	+ 1.1	80	14	29	2	38	1.90	+ .18	0	20	9	1	S.	9,093	2
May.	63.5	− .8	91	19	34	7	43	3.55	− .12	0	28	1	2	SW.	11,050	1
June.	73.3	+ 1.3	96	21	52	2	36	1.73	−1.26	0	27	3	0	S.	11,011	2
July.	72.8	− 3.3	96	11	55	7	31	5.40	+2.23	0	16	13	2	S.	8,460	0
Aug.	74.5	− .1	97	10	58	8	33	2.75	− .60	0	22	9	0	S.	7,891	0
Sept.	67.6	− .1	97	6	36	28	35	1.83	− .53	0	22	7	1	S.	7,259	0
Oct.	56.7	+ .6	86	15	28	27	43	.40	−1.31	1.0	27	4	0	S.	9,812	2
Nov.	45.3	+ 1.5	78	17	11	14	46	.51	− .65	1.3	24	2	4	NW.	7,067	1
Dec.	41.2	+ 4.8	72	16	18	19	41	0	− .83	0	25	4	2	S.	8,337	0
1909:																
Jan.	41.0	+ 7.1	80	8	3	12	63	.70	− .53	.6	26	4	1	S.	10,167	2
Feb.	41.6	+ 4.4	72	12	3	14	55	.28	− .60	T.	22	6	0	S.	10,264	4
Mar.	44.9	− .1	80	22	14	12	45	1.28	+ .63	12.5	21	8	2	NW.	9,542	2
Apr.	54.0	− 1.6	89	17	26	1	45	.50	−1.26	1.6	24	5	1	S.	10,794	4
May.	62.5	− 1.8	93	28	27	1	45	1.08	−2.59	0	21	9	1	S.	9,663	4
June.	73.5	+ 1.5	99	6	52	3	37	4.72	+1.73	0	13	15	2	S.	9,003	2
July.	77.9	+ 1.8	96	11	62	1	30	3.63	+ .46	0	15	16	0	S.	8,270	0
Aug.	78.0	+ 3.4	102	17	57	25	35	.87	−1.94	0	12	17	2	S.	7,599	0
Sept.	69.4	+ 1.7	95	2	45	23	40	2.19	− .17	0	19	11	1	S.	7,906	0
Oct.	57 9	+ 1.8	88	16	29	12	44	1.18	− .53	0	20	7	4	S.	9,619	2
Nov.	50.4	+ 6.6	85	6	26	16	45	3.25	+2.09	6.2	16	7	7	S.	8,456	0
Dec.	31.0	− 5.4	75	31	3	19	40	.54	− .29	5.3	15	10	6	N.	7,878	0
1910:																
Jan.	39.6	+ 5.7	76	1	9	5	40	.05	− .55	.3	10	15	6	SW.	8,483	0
Feb.	35.6	− 1.6	76	14	− 4	17	44	.17	− .71	1.7	15	9	4	N.	8,981	0
Mar.	56.5	+11.0	87	25	31	10	48	.34	− .31	0	24	7	0	S.	9,183	4
Apr.	58.5	+ 3.9	94	29	30	5	43	.59	−1.13	1.1	22	5	3	NW.	9,578	1
May.	61.6	− 2.7	95	10	38	3	39	2.99	− .68	0	10	15	6	N.	9,294	0
June.	75.9	+ 3.9	103	2	50	11	40	.66	−2.33	0	15	15	0	S.	9,629	0
July.	79.5	+ 3.4	100	8	58	1	37	3.57	+ .40	0	15	16	0	S.	8,330	1
Aug.	76.3	+ 1.7	99	28	49	26	36	2.19	− .62	0	18	13	0	S.	7,691	1
Sept.	73.8	+ 6.1	101	11	46	27	44	.05	−2.31	0	16	14	0	S.	8,694	0
Oct.	60.4	+ 4.3	94	4	28	28	45	.26	−1.45	1.6	23	7	1	S.	8,306	0
Nov.	49.0	+ 5.0	82	12	24	30	39	.28	− .88	2.7	23	6	1	S.	7,642	0
Dec.	39.8	+ 3.4	73	9	16	30	42	T.	− .83	T.	15	12	4	S.	8,155	0
1911:																
Jan.	45.6	+11.7	82	31	− 6	3	44	.13	− .47	.5	14	16	1	SW.	9,309	35
Feb.	38.6	+ 1.4	77	1	7	22	37	2.88	+2.00	7.3	18	5	5	SE.	8,370	46
Mar.	51.4	+ 6.4	83	9	21	1	42	.50	− .15	0	25	6	0	S.	9,272	43
Apr.	56.8	+ 2.2	87	22	35	7	42	2.76	+1.04	0	16	11	3	S.	9,732	46
May.	65.6	+ 1.3	92	9	36	1	39	5.88	+2.21	0	15	14	2	SE.	11,140	36
June.	77.0	+ 5.0	105	25	59	4	35	.20	−2.79	0	21	9	0	SE.	8,544	39
July.	75.4	− .7	96	5	54	25	29	3.85	+ .68	0	7	19	5	SE.	7,160	33
Aug.	75.8	+ 1.2	102	6	54	28	38	2.97	+ .16	0	18	11	2	SE.	7,711	30
Sept.	75.2	+ 7.5	95	5	54	19	36	.83	−1.53	0	16	13	1	S.	7,076	33
Oct.	57.1	+ 1.0	91	1	26	28	45	.84	− .87	3.1	18	8	5	S.	8,363	44
Nov.	41.6	− 2.2	75	75	16	5	29	.94	− .22	8.2	10	7	3	SW.	9,651	54
Dec.	30.1	− 6.3	63	4	0	31	33	.95	+ .12	9.0	18	8	5	SW.	6,792	31

[1] In 1911, maximum velocity (miles) recorded during the month.

TABLE IV.—*Monthly climatic data, covering temperature, precipitation, aspect of sky, and wind movement, recorded at the observatory of the United States Weather Bureau, Amarillo, Tex., during the 10-year period from 1907 to 1916, inclusive*—Continued.

Year and month.	Temperature (° F.).							Precipitation (inches).			Aspect of sky (days).			Wind.		
	Mean.	Departure from the normal.	Maximum.		Minimum.		Greatest daily range.	Total.	Departure from the normal.	Snowfall unmelted.	Clear.	Partly cloudy.	Cloudy.	Prevailing direction.	Movement.	Maximum velocity (miles).
			Reading.	Date.	Reading.	Date.										
1912:															*Miles.*	
Jan.	31.2	− 2.7	75	26	−11	6	50	T.	−0.60	T.	18	13	0	N.	8,234	37
Feb.	35.6	− 1.6	72	18	6	4	33	1.94	+1.06	16.3	17	8	4	NW.	7,910	44
Mar.	39.2	− 5.8	81	19	13	20	57	.82	+ .17	3.5	14	10	7	N.	10,047	39
Apr.	54.6	.0	89	30	31	2	39	.72	−1.00	T.	20	9	1	SW.	10,030	45
May	66.6	+ 2.3	95	24	38	14	38	1.67	−2.00	0	21	8	2	SW.	9,077	40
June	70.4	− 1.6	95	30	41	18	39	1.90	−1.09	0	18	11	1	SW.	7,788	31
July	79.2	+ 3.1	99	30	60	16	33	1.88	−1.29	0	21	10	0	SW.	8,585	38
Aug.	76.4	+ 1.8	97	26	55	9	32	2.28	− .53	0	21	9	1	SW.	8,416	40
Sept.	64.6	− 3.1	92	2	36	26	35	2.28	− .08	0	15	13	2	SW.	8,573	40
Oct.	58.2	+ 2.1	83	4	28	22	40	.39	−1.32	0.6	21	9	1	SW.	8,377	32
Nov.	46.9	+ 3.1	78	10	13	27	42	.02	−1.14	0.2	23	6	1	SW.	8,917	42
Dec.	33.6	− 2.8	66	14	9	24	40	1.80	+ .35	11.4	24	5	2	SW.	8,316	37
1913:																
Jan.	35.0	+ 1.1	67	29	− 2	7	38	.11	− .49	1.1	21	10	0	SW.	10,427	38
Feb.	31.6	− 5.7	71	18	8	8	43	.55	− .33	5.1	14	10	4	NE.	6,553	27
Mar.	43.3	− 1.7	80	30	10	24	44	.59	− .06	5.4	22	9	0	SW.	10,973	44
Apr.	56.2	+ 1.6	87	17	28	4	43	1.76	+ .04	1.4	26	3	1	SW.	10,022	39
May	68.2	+ 3.9	94	29	44	15	39	1.41	−2.26	0	26	4	1	S.	9,355	34
June	70.2	− 1.8	93	2	51	10	34	2.32	− .67	0	17	8	5	S.	8,476	32
July	78.7	+ 2.6	101	14	58	21	34	1.80	−1.37	0	26	5	0	S.	9,493	36
Aug.	80.0	+ 5.4	99	9	61	2	33	.61	−2.20	0	27	4	0	S.	7,490	30
Sept.	64.8	− 2.9	94	7	38	28	38	4.19	+1.83	0	18	6	6	S.	7,349	38
Oct.	55.2	− .9	85	14	24	29	46	.81	− .90	.7	22	9	0	SW.	8,492	44
Nov.	50.3	+ 6.5	79	19	32	8	39	1.98	+ .82	0	18	6	6	SW.	8,558	40
Dec.	33.2	− 3.2	54	11	4	23	35	2.84	+2.01	12.1	17	7	7	N.	6,945	37
1914:																
Jan.	45.4	+ 9.8	82	27	20	30	38	.06	− .5	.6	23	7	1	W.	7,446	42
Feb.	38.2	+ 1.0	77	17	− 1	6	57	.10	− .8	.8	21	5	2	SW.	7,225	36
Mar.	47.3	+ 2.3	82	15	14	20	47	.15	− .5	1.4	22	8	1	SW.	7,349	37
Apr.	56.0	+ 1.4	88	21	20	8	41	.95	− .8	1.8	15	13	2	SW.	9,827	40
May	63.2	− 1.1	95	10	42	12	36	4.43	+ .8	0	15	13	3	S.	8,416	37
June	76.2	+ 4.2	99	26	57	17	33	.84	−2.2	0	24	6	0	SW.	10,429	40
July	77.8	+ 1.7	97	31	60	2	30	3.07	− .1	0	19	12	0	S.	6,023	40
Aug.	75.6	+ 1.0	94	31	57	28	33	2.97	+ .2	0	19	11	1	S.	6,559	31
Sept.	72.8	+ 5.1	98	6	49	28	33	1.07	−1.3	0	21	9	0	S.	7,938	40
Oct.	58.0	+ 1.9	86	17	30	27	41	4.46	+2.8	0	14	9	8	S.	8,184	30
Nov.	50.4	+ 6.6	76	14	23	17	40	T.	−1.2	0	26	4	0	SW.	6,069	28
Dec.	30.4	− 6.0	62	18	10	21	36	1.17	+ .3	0	13	11	7	SW.	7,450	35
1915:																
Jan.	34.0	+ 0.1	64	14	9	22	50	.72	+ .1	5.9	22	7	2	SW.	9,049	40
Feb.	41.4	+ 4.2	76	10	20	28	45	1.60	+ .7	9.9	20	6	2	NW.	8,179	44
Mar.	37.2	− 7.8	78	24	17	21	47	1.00	+ .4	8.1	14	12	5	N.	8,180	40
Apr.	57.0	+ 2.4	88	28	29	1	38	5.05	+3.3	1.7	13	11	6	S.	7,997	46
May	61.5	− 2.8	92	25	30	7	41	1.70	−2.0	.....	21	5	5	S.	9,263	44
June	72.4	+ .4	103	20	42	7	37	1.04	−2.0	.....	19	8	3	S.	8,841	37
July	74.6	− 1.5	102	11	52	5	32	4.14	+1.0	.....	15	10	6	S.	8,893	44
Aug.	71.4	− 3.2	95	4	48	30	32	5.85	+3.0	.....	20	8	3	S.	6,232	27
Sept.	68.8	+ 1.1	94	10	47	30	33	4.69	+2.3	.....	23	4	3	S.	7,860	33
Oct.	59.0	+ 2.9	83	2	37	26	36	1.55	− .2	.....	28	3	0	SW.	7,735	30
Nov.	49.5	+ 5.7	82	5	20	14	45	.18	−1.0	1.8	28	0	2	SW.	9,070	42
Dec.	40.2	+ 3.8	73	22	8	28	42	.13	− .7	.2	22	5	4	W.	8,275	40
1916:																
Jan.	35.2	+ 1.3	74	9	1	13	55	.36	− .2	2.5	14	9	8	SW.	8,740	36
Feb.	43.5	+ 6.3	81	11	9	1	54	.02	− .9	.2	24	5	0	NE.	7,022	32
Mar.	53.7	+ 8.7	87	13	16	3	46	.57	− .1	4.0	28	2	1	NE.	9,687	40
Apr.	52.9	− 1.7	87	11	26	8	47	1.71	.0	T.	18	7	5	NE.	9,123	42
May	67.0	+ 2.7	98	31	35	1	52	.89	−2.8	.....	26	4	1	SW.	9,585	37
June	74.6	+ 2.6	100	21	50	7	37	2.18	− .8	.....	17	11	2	S.	8,988	35
July	79.0	+ 2.9	100	3	61	7	32	.94	−2.2	.....	19	12	0	S.	6,856	25
Aug.	76.6	+ 2.0	97	13	55	28	28	3.82	+1.0	.....	19	10	2	S.	7,652	39
Sept.	67.8	+ .1	91	10	40	29	38	1.76	− .6	.....	18	12	0	S.	8,174	35
Oct.	57.2	+ 1.1	89	3	27	19	39	2.90	+1.2	.....	19	4	8	S.	8,091	37
Nov.	44.4	+ .6	85	4	5	14	42	.40	− .8	3.7	23	3	4	SW.	8,233	35
Dec.	36.6	+ .2	73	4	0	21	40	.88	+ .05	6.3	21	7	0	SW.	9,145	40

Temperature.

The daily range in temperature is large, but not excessive. In general, the days in summer are warm to hot and the nights nearly always cool. Owing to the altitude (3,600 feet) the summer temperatures are not as high as might be expected from the southern location. On the other hand, winter temperatures are not as low as might be expected from the elevation.

The data on maximum, mean, and minimum temperatures and greatest daily range, by months, in the 10 years from 1907 to 1916, inclusive, are given in Table IV, which also contains data on precipitation, the aspect of the sky, and the movement of the wind. The lowest recorded temperature in the period covered by these records was −11° F. on January 6, 1912, and the highest 105° F. on June 25, 1911. The average date of the last spring frost is April 19 and that of the first fall frost October 30, leaving an average frost-free period of 194 days.

Evaporation.

The loss of moisture by evaporation in the Panhandle district is very great. The chief factors concerned are precipitation, wind, and temperature. The maximum evaporation naturally occurs, therefore, in periods of high temperatures and strong winds.

Table V contains a comparison of monthly precipitation and evaporation records made at the Amarillo Cereal Field Station[1] during the six months from March to September in the 10-year period from 1907 to 1916, inclusive. The evaporation measured is from the free water surface of a tank 8 feet in diameter. During this period, the evaporation was nearly four times as great as the precipitation during the same period. In 1909 a maximum of 0.69 of an inch was evaporated from this tank in 24 hours. These data show contributing causes for certain crop results in various years.

Table V.—*Monthly, seasonal, and 10-year monthly average precipitation and evaporation, in inches, at the Amarillo Cereal Field Station, during the six months from April to September, inclusive, for the 10-year period from 1907 to 1916, inclusive.*

Year.	April.		May.		June.		July.		August.		September.		Seasonal total.	
	Prec.	Evap.	Prec.	Evap.	Prec.	Evap.	Prec.	Evap.	Prec.	Evap.	Prec.	Evap.	Prec.	Evap.
1907....	1.3	6.4	1.1	8.1	2.2	9.6	1.5	10.7	6.2	9.4	1.0	7.9	13.3	52.1
1908....	1.9	7.3	3.4	9.3	1.7	10.4	4.6	8.1	3.4	8.6	1.5	6.8	16.5	50.5
1909....	.3	8.1	1.1	10.0	5.9	10.3	2.2	10.0	1.4	9.7	1.9	8.4	12.8	56.5
1910....	.5	8.5	2.6	8.0	1.5	12.0	2.6	12.2	2.5	8.8	.1	9.1	9.8	58.6
1911....	3.9	7.4	6.7	10.1	.4	11.5	5.9	7.5	2.5	8.9	1.3	7.3	20.7	52.7
1912....	.8	7.1	1.6	9.9	2.3	9.0	2.5	10.9	1.5	9.5	2.3	6.5	11.0	52.9
1913....	1.7	7.7	1.7	9.8	2.3	7.0	1.4	12.7	.5	10.3	5.6	5.9	13.2	53.4
1914....	1.3	6.7	3.8	6.7	.7	10.1	1.9	8.7	2.5	8.9	1.1	8.0	11.3	49.1
1915....	4.8	4.6	2.0	6.9	1.2	8.8	3.7	9.3	4.6	7.3	4.9	6.0	21.2	42.9
1916....	1.8	6.0	.9	10.3	2.7	10.7	1.2	11.7	3.4	10.2	2.2	7.7	12.2	56.6
Av.	1.8	7.0	2.5	8.9	2.1	9.9	2.8	10.2	2.9	9.2	2.2	7.4	14.2	52.5

[1] The precipitation and evaporation data given in Table V were obtained at the Amarillo Cereal Field Station in cooperation with the Office of Biophysical Investigations and the Office of Dry-Land Agriculture of the Bureau of Plant Industry, U. S. Department of Agriculture.

RECENT AGRICULTURAL HISTORY.

Not more than 15 or 20 years ago the Panhandle was occupied by immense cattle ranches, used only for grazing purposes. The dense growth of short but nutritious grasses, chiefly buffalo grass and blue grama, furnished both winter and summer pasturage for countless numbers of beef cattle, which had no other feed from weaning time to marketing. Under this system from 15 to 40 acres of grazing land were required for each animal, depending on the nature of the grass cover, the character of the season, and the time of year.

Between 1890 and 1900, conditions in the stock-ranch industry became unsatisfactory and a change began. Overstocking the range had resulted in heavy losses during seasons of drought and during severe winters. A call for feeding crops suited to the Plains was coming from the ranchers. The demand for new, cheap lands for homes and crop production was increasing. The large ranches were being divided and portions sold for farms. This process is still going on throughout the range country.

Most of the settlers came from the more humid States of the Mississippi Valley area, where conditions are almost entirely different. Some of them brought the proceeds of high-priced lands and invested heavily; others came with only meager equipment and financial resources. Few of them had knowledge of the crop varieties or cropping methods most likely to be successful under the rigorous conditions prevailing on the high, dry plains. Most of them came expecting to grow the crops they had previously grown in more humid sections. An increasing demand for information came from new settlers who wanted suitable field crops and from ranchmen who wanted feeding crops.

THE CEREAL FIELD STATIONS.

In response to the increasing demand for information on dry-land crops, experimental work was begun by the Office of Cereal Investigations in 1903. Experiments were conducted for three years at Channing, Tex., on the X I T Ranch. In 1906 the work was transferred to Amarillo, Tex., where it has since been conducted. The work there was started on farm No. 1, situated 1 mile southwest of the town. In 1910 it was transferred to farm No. 2, which lies about 2 miles northeast of the town.

Amarillo is located in what is known on the Plains as "tight" land, a dark, clay loam, bearing a close turf of buffalo and grama grasses. The average rainfall is about 21 inches annually. This location is fairly representative of a considerable part of the Panhandle. The results obtained there are applicable to most of the Panhandle and to small adjacent portions of New Mexico and Oklahoma.

THE GRAIN SORGHUMS.

The grain sorghums consist of several very distinct groups of varieties. Different groups and varieties react differently to environmental conditions and therefore give different results. To understand these results it is necessary to know the characters by which the groups and varieties differ from each other. For this purpose a glance is taken first at the relationship of the grain sorghums to other sorghums. Keys to the groups of grain sorghums and brief descriptions of them are inserted next, and finally keys and descriptions covering the varieties in each group are presented.

CLASSIFICATION.[1]

The different sorghums grown in this country may be arranged in a general way in four agronomic divisions, as noted below.

(1) Grain sorghums, which include such well-known groups as kafir, durra and milo, and kaoliang, and also less commonly grown groups, such as shallu, etc.

(2) Sorgo, or forage sorghum, known also as sweet or saccharine sorghum, and improperly called "cane" or "sugar cane." This group includes such well-known varieties as Amber, Orange, and Sumac, as well as many others not so widely grown.

(3) Broom corn, which includes two rather distinct varieties, Standard and Dwarf.

(4) Hay sorghums, which include Johnson, Sudan, and Tunis grasses.

This bulletin is concerned only with the grain-producing sorghums. Figure 3 shows representative kernels of the most important varieties. The groups of the grain-sorghum section may be separated by the following key:

Spikelets broadly obovate, 4.5 to 6 mm. wide; seeds large, lenticular, flattened; panicle oval-ovate, short branched, compact.....DURRA-MILO.

Spikelets oval or narrowly obovate, 2 to 4 mm. wide; seeds midsized to small, ovoid, scarcely flattened.

- Stems stout, somewhat juicy; internodes short; leaves 12 to 15, broad, usually dark green.....KAFIR.
- Stems slender, dry; internodes longer; leaves 7 to 10, narrower and lighter green:
  - Panicle compressed; glumes tightly appressed to the brown or white seeds.....KAOLIANG.
  - Panicle conical, loose; glumes spreading, exposing yellowish white seeds.....SHALLU.

THE DURRA-MILO GROUP.

This group includes White and Brown durra, feterita, and White and Yellow milo. It is characterized by slender to midstout, dry, pithy stems, 0.8 to 2 meters tall, bearing 7 to 10 rather small leaves; panicles short, broad, ovate or oval, short branched, compact;

[1] Classification studies in sorghums were made by the senior writer during the period of 1903 to 1906, inclusive. All obtainable domestic varieties and several hundred foreign varieties and strains were grown and studied. Acknowledgment of valued cooperation in this work is made to Director W. R. Dodson, of the Louisiana Experiment Station, to former Director A. M. Soule, of the Tennessee Agricultural Experiment Station, and to their assistants.

spikelets broadly obovate, 4.5 to 6 mm. wide; seeds broadly obovate to lenticular, 4 to 6 mm. in diameter, rather strongly flattened. The varieties of this group may be separated by the following key:

Glumes greenish white, densely pubescent, not transversely wrinkled; seeds much flattened.....DURRA.
  Seeds white; lemmas awned.....*White durra.*
  Seeds brown; lemmas not awned.....*Brown durra.*
Glumes dark brown to black, thinly pubescent to glabrate, transversely wrinkled; seeds less flattened.
  Panicles narrowly oval, always erect; lemmas not awned; seeds chalky or bluish white.....FETERITA.
  Panicles broadly oval or ovate, inclined to pendent; lemmas awned; seeds white or brown.....MILO.
    Seeds white.....*White milo*
    Seeds brown.
      Stems 1.2 to 2 meters high.....*Milo.*
      Stems 0.8 to 1.3 meters high.....*Dwarf milo.*

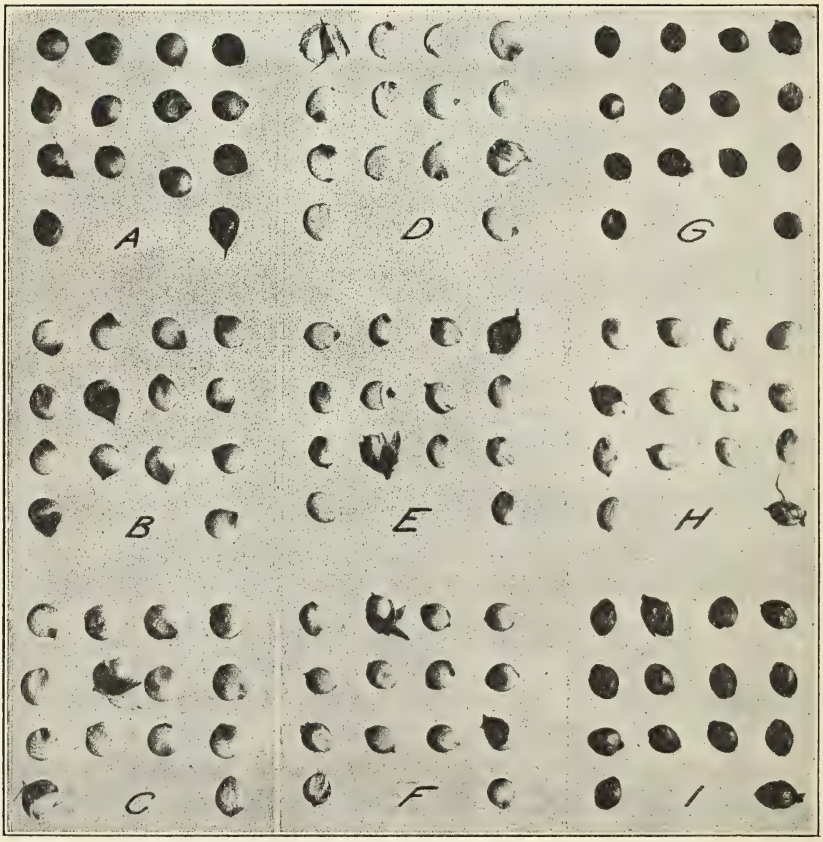

FIG. 3.—Seeds of nine varieties of grain sorghums, representing all the different groups: *A*, Milo; *B*, Alba milo; *C*, feterita; *D*, White durra; *E*, Durra-kafir hybrid (No. 198-7-3); *F*, Blackhull kafir; *G*, Red kafir; *H*, Mukden (white) kaoliang; *I*, Manchu (brown) kaoliang. (All natural size.)

The Kafir Group.

The kafir varieties are known by their stout, stocky, semijuicy stems, with short internodes and overlapping sheaths; leaves 11 to 16, broad; panicles erect, cylindrical, linear or narrowly to broadly oblong, heavy; spikelets obovate, 2.5 to 4 mm. wide; glumes much shorter than the seed; lemmas not awned.

The six varieties grown in this country may be distinguished by the following key:

Seeds white.
  Glumes black.
    Stalks 1.5 to 2.4 meters tall.
      Maturing late ..... *Blackhull kafir.*
      Maturing midearly ..... *Sunrise kafir.*
    Stalks 0.9 to 1.3 meters tall; maturing midearly. *Dawn (Dwarf Blackhull) kafir.*
  Glumes white ..... *White kafir.*
Seeds pink.
  Glumes white ..... *Pink kafir.*
Seeds red.
  Glumes black ..... *Red kafir.*

The Kaoliang Group.

Stems slender, dry, pithy, 0.8 to 3 meters tall; leaves 8 to 11, small, narrow; panicle variable, mostly narrowly oval to oblong or clavate; spikelets obovate or oval, 2.5 to 3.3 mm. wide; lemmas always awned; seeds oval, often pointed, white or various shades of brown.

A large number of varieties of kaoliang have been grown in adaptation and classification studies. Most of these have been discarded, however, and it is not necessary to classify and separate them here.

Only one of these varieties has become established as a farm crop. This variety, the Manchu (Cereal Investigations Nos. 171 and 328), is now grown to some extent in South Dakota, and its use there seems to be increasing. It is a very early maturing variety, of medium height, 1.2 to 2.1 meters tall, with a narrowly oval, semicompact panicle 8 to 10 inches long, black glumes, and dark-brown seeds. The varietal name, Acro, has recently been given by the South Dakota Agricultural Experiment Station to a selection of the Manchu variety.

The Shallu Group.

Only one variety of the shallu group is found in the United States, and it apparently has little or no value for dry-land conditions. It grows from 1.5 to 2.4 meters tall, has slender, dry stems bearing 11 to 15 leaves of medium size, and large, loose, conical, pale-yellow panicles, 2 to 4 dm. long. The glumes are yellowish and at maturity spread wide apart and the edges become inrolled, completely exposing the small, oval, pale-buff seed.

EXPERIMENTAL CONDITIONS.

In order that the experimental results may be properly interpreted, descriptions of the methods of obtaining data and of the environing conditions prevailing in each season are given here.

Methods Employed.

The size and arrangement of plats, the method and rate of seeding, the date when the crop was sown each year, the rotation of crops on the experimental area, and the methods of obtaining certain data are explained in the following paragraphs.

SIZE AND ARRANGEMENT OF PLATS.

The plats used in these experiments were 8 rods long by 2 rods wide, containing a tenth of an acre each. These plats were laid out in blocks of 10. Each block was bordered on all four sides by a road 19.2 feet wide. Each plat, therefore, had a road at each end, and the first and tenth plats in each group or block had a road on one side. A guard row usually is placed between the first and tenth plats and the adjacent roads.

In the experiments with small grains, definite alleys are left between plats, to prevent mixing and to facilitate the handling of the crop. Since the grain sorghums are sown in widely spaced rows no alleys were needed for these purposes, and usually none were left. The regular 42-inch space between rows served as an alley. In 1910, however, 5-foot alleys were left between the plats, thus giving the crop thereon the benefit of 9 inches of extra space on each side of the plat.

Each plat contained 10 rows, 132 feet long and 42 inches apart. Usually each variety occupied 10 rows, or a tenth of an acre. Sometimes, however, fewer than 10 rows were sown. In 1914 all varieties were sown on 5-row or twentieth-acre plats. In sowing the varieties the rows were made longer than 132 feet. When the plants were 15 to 20 inches (4 to 5 dm.) in height, the ends of the rows were trimmed to the proper limits.

METHOD AND RATE OF SEEDING.

A 1-row corn drill, fitted with special sorghum plates, was used for sowing the crop until 1910. Since then a 2-row corn drill, fitted in the same manner, has been used. The plates for sowing milo and durra contain 18 holes, each three-sixteenths of an inch in diameter. For kafir the plates have 16 holes, each five thirty-seconds of an inch in diameter, and for kaoliang 25 holes the same size as for kafir. The feed was run on high gear, which drops at intervals of 6.4, 7.2, and 4.6 inches, respectively, with plates bored as stated above.

It was the intention to have only one kernel dropped at a time, but in many cases two and sometimes three kernels were dropped because of the thickness of the plates and the varying size of the kernels.

DATES WHEN THE CROPS WERE SOWN.

In 1908 the Blackhull and Red Kafir varieties were sown on May 20 and 21; the other varieties between May 27 and 30. In 1909, seeding began on May 25 and ended on June 2, while in 1910 the beginning was on May 24 and the end on May 28. In 1911 the sowing occupied June 3 to 8, inclusive. In 1912 and 1913 these crops were sown during the eight days from May 20 to 27, inclusive, while in 1914 sowing was condensed into the 3-day period, May 23 to 25. In the last two years only two days have been required to sow all varieties. The sowing was done in 1915 on May 24 and 25 and in 1916 on May 25 and 26.

ROTATIONS ON THE EXPERIMENTAL AREA.

Owing to the lack of land and the shifting of the location from one farm to another in 1910 it was not possible to establish a regular rotation on the experimental plats. In 1908 most of the varieties were sown on sod land which had been broken during the previous fall and winter. In 1909 the varieties were scattered over the farm on various blocks which had been cropped to different small grains the year before.

In 1910 the crops were sown on land broken late in the autumn of 1909 and in January, 1910. The milos and durras and part of the brown-seeded kaoliangs, including Manchu and Valley, were sown on the later breaking. This did not contain as much moisture as the fall breaking and the crops on it showed the difference to some extent.

In 1911 all varieties except the Blackhull kafirs and the durra-kafir hybrids were sown on sod broken during the previous fall and winter. The two groups named above were on land which had borne a crop of small grain in 1910. In the last five years, 1912 to 1916, inclusive, the grain-sorghum varieties have followed small grains in all cases.

METHODS OF OBTAINING DATA.

The data on plant space and stalk space and on the occurrence of suckers and erect heads have been obtained by actual counts of the plants, stalks, and heads in all the rows of each plat for which such data are given. The percentage of suckers is the difference between the number of stalks and the number of plants, divided by the number of stalks. It is thus a percentage of the total number of stalks in the plat and not a percentage of the number of plants.

The growing period as given here is the total time elapsing from seeding until the grain is ripe. The vegetative period is the first and larger portion of the growing period from seeding until the heads have appeared. If heading is progressing slowly and unevenly the growing period is counted as ending when 50 per cent of the stalks have headed. The ripening period is the complement of the vege-

tative period and covers the time elapsing between heading and ripening.

The height of the plants is the average of measurements made at several, usually 10, points in the plats.

The varieties are all harvested with a corn binder, leaving a stubble varying in height from 5 to about 8 inches (1 to 2 dm.), depending on the height of the standing plants. The bundles are shocked in the field and allowed to cure for four to six weeks before being thrashed. The shocks are then hauled to the scales and weighed.

The heads are cut from the bundles by means of a large knife fastened to the edge of a box. Very dwarf strains are not headed, but are thrashed in the bundle unless the weight of the heads is desired. Since the stalks often are not of uniform height, the piece of the peduncle or stem left attached to the heads also varies in length. In general it averages about 10 to 12 inches (2.5 to 3 dm.) long. Where it is desired to determine the proportion of heads in the total crop, the heads are weighed before thrashing and the percentage computed.

Thrashing has been done with a small separator. The thrashed seed is weighed as it comes from the separator and the acre yield computed therefrom.

The yields are based on 60 pounds to the bushel of kafir and 58 pounds of all other varieties. After weighing, the thrashed seed is run through a fanning mill and the bushel weight then determined with the standard tester.

Environing Conditions.

To aid in an understanding of the results obtained during the 9-year period from 1908 to 1916, inclusive, a brief summary of seasonal conditions is given and their effects on crop growth and production are noted. Figure 2 shows the annual and seasonal (April to September, inclusive) precipitation during the 10-year period from 1907 to 1916, inclusive.

The season of 1908 was favorable to good yields. The precipitation in the last three months of 1907 was slightly above normal, but in the first three months of 1908 it was considerably below normal. This left little or no stored moisture at the end of March. However, the rainfall in April, May, and June was about normal and fully sufficient for plant growth. With a rainfall of nearly 2 inches above normal in July and August, most of which fell in July, conditions were favorable for a heavy grain yield. Dwarf milo averaged over 41 bushels and Blackhull kafir a little less than 34 bushels per acre.

The season of 1909 was variable and unfavorable. It consisted of a dry spring and a dry summer with a wet June intervening. Precipitation in the winter of 1908–9 was decidedly below normal. The

rainfall in March was slightly above normal, but in April and May there was a deficit of 3.5 inches, which left the soil in a very dry condition. June and the first week in July were abnormally wet, inducing strong vegetative growth. From July 8 to the end of August the weather was intensely hot and dry. None of the crops were headed at the time the drought began. The effect of the sudden and severe drought occurring just at this critical stage was to prevent the development of heads on many of the plants, which resulted in low yields of grain. The average yield from the milos was only 6 bushels and from the Dwarf milo 11 bushels. The kafirs, being later, were not so near the critical heading stage when overtaken by drought and were better able to await the fall rains. Their average yield was 12 bushels per acre.

The year 1910 was the driest of the 18 years in which weather data had been recorded at Amarillo. The precipitation during the entire year amounted to only 11.1 inches, or about half of the normal for the 18-year period. Each month in the year was abnormally dry, although the scanty rainfall was fairly well distributed. All but 2 inches fell in the four summer months from May to August, inclusive. However, there was no effective rainfall from May 21 until July 9. The latter half of July also was a period of intense drought, which was continued to the end of the season except for a 10-day period in early August. The droughts of July and August caught both early and late varieties in the critical heading stage and reduced the yields materially, those of the late varieties being most affected. The average acre yield from milo was 17.8 bushels, from Dwarf milo 19 bushels, and from Dawn (dwarf) kafir, a later crop, only 8.9 bushels. The still later standard kafirs were almost completely barren.

The year 1911 was fairly favorable to grain sorghums. The winter of 1910–11 was very dry. There was neither rain nor snow of value until after the middle of February. In the next six weeks, however, the precipitation amounted to about 6 inches, which penetrated the soil to a depth of several feet. Almost 6 inches more had fallen by the end of May. On account of the soaked soil, planting was delayed until June 6. Although June was abnormally dry, the reserve stock of moisture was more than sufficient for crop needs. July was well watered, but a real drought occurred in the first three weeks of August. The average acre yields of all varieties and selections in the best adapted groups were as follows: Milo, 32.3 bushels; Dwarf milo, 37.6 bushels; feterita, 31.9 bushels; and Dawn kafir, 34.9 bushels.

The year 1912 was very dry, the total precipitation being only 14.3 inches. The only rains of consequence were on February 25, June 11, July 30, August 3 and 4, and September 11. This was a fair

distribution, but the scanty total and the long drought from June 11 until the end of July reduced yields very much. The average acre yields produced by the leading groups were as follows: Milo, 19 bushels; Dwarf milo, 22.6 bushels; feterita, 24.5 bushels; and Dawn kafir, 9.6 bushels. The standard kafirs averaged less than half as much as the Dawn.

The precipitation of 1913 was only 2 inches below normal and therefore should have been sufficient for the production of good crops. Owing to its very uneven distribution, however, the grain-sorghum crops were almost complete failures. The table of daily precipitation (p. 9) shows that the early summer was dry, that most of the showers of June were too small in quantity to be effective, and that in the three months from June 12 to September 10 only one effective precipitation occurred, namely, that of July 25–28, inclusive. Only the plants at the ends of the rows were able to develop heads under these conditions. The rain of September 10–11 came too late to revive the others, and no yields were obtained.

The year 1914 returned about a half crop. The winter of 1913–14 was unusually wet in its first half and abnormally dry in its second half. January, February, and March, 1914, were "bone" dry. April brought only light showers. The rainfall of May was above normal, but the temperatures at sowing time were low, and rather poor germination resulted. June was remarkably dry, and the scattered rains of the first week in July relieved the suffering plants but temporarily. The drought of the remainder of July cut down the number of heads that were able to emerge, but the rains of early August were sufficient to mature these in spite of the subsequent drought. The average acre yields of the leading groups were as follows: Milo, 11 bushels; Dwarf milo, 26.9 bushels; feterita, 18.5 bushels; and Dawn kafir, 14.7 bushels.

In general, the seasonal conditions in 1915 were good. The total precipitation recorded at the cereal field station was 25.1 inches, while that recorded by the Weather Bureau observer in town was 27.6 inches, a difference of 2.5 inches. Either quantity is sufficient for the growth of these crops, and the distribution was such that growth was not interrupted at any time. While the rainfall in both May and June was below normal, that of April was much above, and the distribution in the two dry months was good. The three succeeding months were abnormally wet. The combined result was the highest yields that have ever been obtained at the Amarillo Cereal Field Station. The average acre yield of all lots of milo was 61.4 bushels; of Dwarf milo, 68.4 bushels; of feterita, 46.9 bushels; of Blackhull kafir, 51.9 bushels; and of Dawn kafir, 53.3 bushels.

The season of 1916 was very dry and unfavorable to the grain sorghums. The total precipitation recorded at the field station was

only 16.6 inches, or about 5 inches below normal. While April and June had fair quantities of rain, there was really only one effective rain in each of the four months from April to July, inclusive, and none between June 4 and July 29. The good rains of August did not begin until the 20th, after which there was drought again. It is not surprising, therefore, that low yields were obtained. The average acre yields of the leading groups were as follows: Milo, 7 bushels; Dwarf milo, 8.6 bushels; feterita, 12.2 bushels; and Dawn kafir, 3.7 bushels. Standard kafir failed to mature.

VARIETAL EXPERIMENTS.

The objects of the experiments reported herein were to determine the adaptation and value of the different groups and the best varieties in each group. Studies on the best methods of growing the crop were also made, but the results will appear elsewhere.

Preliminary experiments with two or three varieties had been conducted at Channing, Tex., from 1904 to 1906, inclusive. At Amarillo the work was begun in 1906 by Mr. A. H. Leidigh, in charge of the work with cereals at the Amarillo Cereal Field Station. Three varieties were grown in field plats in 1906, with acre yields as follows: Blackhull kafir, 44.4 bushels; Red kafir, 42.9 bushels; and shallu, 26.1 bushels. In 1907 only two varieties were grown in plats, milo yielding 23.9 bushels and Blackhull kafir 18.9 bushels. Experiments in methods of tillage, rates of seeding, and the improvement of varieties were begun also by Mr. Leidigh.

In 1907 the senior writer began active direction of the experimental work with these crops, and the comprehensive series of varietal and other tests here recorded was planned for the year 1908. The junior writer has been associated in the investigations since July, 1909, and has been acting in charge of the experiments since 1914.

The results obtained from all the lots, selections, and races of all the varieties under experiment in any or all of the nine years from 1908 to 1916, inclusive, are presented in the tables that follow. The importance of the ecologic study of the grain sorghums has been shown in the introduction to this bulletin. The same reasons which require a full presentation of the climatic factors require as well a presentation of all the agronomic data available, so far as they serve to show the comparative response of these crops to environing conditions each season.

The data in the tables include not only the yields, therefore, but many other agronomic data as well. Among them are the average drill-row space occupied by each plant and each stalk; the length, in days, of the vegetative and fruiting periods and of the total growing period, the percentage of suckers, the height of the plants, and, in

the milos, the percentage of erect heads. Finally, in some cases, data are given covering the weight of the heads and of the total crop and the proportion by weight of the heads in the total crop and of seed in both heads and total crop.

The different groups of varieties vary considerably in the size of the plants and in earliness and therefore in probable water requirement. From a study of the tables it will be noted that they also vary greatly in their ability to produce from year to year under Panhandle conditions. In the first place, long-season or late-maturing varieties have ripening periods that fall after the warm weather conducive to rapid ripening is well past. Hence, early-maturing varieties are at an advantage. In the second place, in the frequent seasons when the water supply is deficient, dwarf and early varieties with water requirements which are comparatively low or of comparatively short duration are best able to produce good yields.

The tabulated data show clearly that such varieties as milo and Dwarf milo, which are both comparatively early and dwarf, nearly always outyield the larger and later kafirs. Among the kafirs themselves the advantage is always with the earlier and dwarfer varieties.

The Milo-Durra Group.

The two subgroups and the varieties included in each have been described previously and separated by means of a simple key. These plants are low to midtall, with midsized dry stems and only seven or eight leaves. The heads are broad and comparatively short, either erect or on more or less recurved peduncles. The seeds are either brown or white, broadly oval or sublenticular in outline, and more or less flattened. The group contains two out of the three commercially important varieties, namely, milo and Dwarf milo, the third being Blackhull kafir.

All the varieties, except one or two of the milo hybrids, are early to midearly in maturing. The dry stems ripen with or before the seeds, and the leaves also become dry and often break off and blow away in windy weather. On the whole, the water requirements of the milos and durras are probably as low as those of any of the groups. Their earliness requires that the water supply be maintained during only a comparatively short period. These adaptations give them the power to produce well even in somewhat unfavorable seasons. Their chief handicap is a tendency to produce recurved, or gooseneck, heads in all the varieties except feterita.

The results obtained from the different varieties in this group are presented in Tables VI to XVIII, inclusive. In general, Dwarf milo is the best of all the varieties. Standard milo and feterita rank second, with White milo third.

TABLE VI.—*Agronomic data for standard milo grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Heads in crop.	Seed in—		Yields per acre.			
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.				Crop.	Heads.	Total crop.	Heads.	Seed.	
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Perct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Bus.*
223	8.6	5.0	76	29	105	41.9	70.0	.....	.....	.....	.....	.....	2,170	37.4
224	.....	.....	76	29	105	.....	.....	.....	.....	.....	.....	.....	2,610	45.0
227	9.0	5.5	76	29	105	38.9	52.3	.....	.....	.....	.....	.....	1,718	29.6
229	.....	.....	76	29	105	.....	.....	.....	.....	.....	.....	.....	1,763	30.4
230	11.1	5.5	76	29	105	59.5	56.1	.....	.....	.....	.....	.....	1,955	33.7
231	.....	.....	76	29	105	.....	.....	.....	.....	.....	.....	.....	2,065	35.6
232	8.9	4.8	76	29	105	46.0	65.7	.....	.....	.....	.....	.....	1,765	30.4
234	9.7	5.1	74	28	102	47.4	53.0	.....	.....	.....	.....	.....	2,506	43.2
331	8.8	4.9	76	28	105	44.3	68.9	.....	.....	.....	.....	.....	2,320	33.3
Average	9.3	5.1	75.8	28.8	104.5	46.3	61.0	.....	.....	.....	.....	.....	2,097	35.4
1909:														
77	13.2	7.4	72	.....	.....	43.9	98.4	.....	.....	61.7	.....	448	276	4.8
223	14.1	6.0	71	.....	.....	57.5	97.3	.....	.....	55.2	.....	1,730	955	16.5
224	15.1	6.7	72	.....	.....	49.3	97.7	.....	.....	66.9	.....	1,165	780	13.5
224–3	13.9	6.3	85	.....	.....	54.6	96.5	.....	.....	.....	.....	.....	.....	1.8
231	15.9	7.9	83	.....	.....	50.3	96.0	.....	.....	.....	.....	.....	.....	1.4
232	13.8	7.3	77	.....	.....	47.0	98.7	.....	.....	.....	.....	.....	.....	3.6
234	12.0	8.1	85	.....	.....	32.5	97.6	.....	.....	62.0	.....	193	120	2.1
234	12.9	7.3	75	.....	.....	43.4	98.8	.....	.....	67.7	.....	450	305	5.3
234	11.6	5.8	75	.....	.....	50.0	98.6	.....	.....	67.6	.....	490	331	5.7
234	8.7	6.1	74	.....	.....	29.8	98.9	.....	.....	67.7	.....	635	430	7.4
234	6.2	4.7	72	.....	.....	24.2	99.2	.....	.....	66.7	.....	750	500	8.6
235	11.4	9.0	72	.....	.....	21.0	96.5	.....	.....	61.1	.....	103	63	1.1
Average	12.4	6.9	76	.....	.....	41.9	97.8	.....	.....	64.0	.....	663	.....	6.0
1910:														
77	26.8	9.9	79	33	112	62.9	62.1	64.8	34.4	53.2	3,194	2,069	1,100	19.0
223–6	32.3	11.9	79	33	112	63.1	63.1	63.1	34.1	54.1	3,189	2,012	1,089	18.8
224	23.0	7.9	77	35	112	65.4	71.7	61.6	32.4	52.6	3,443	2,120	1,115	19.2
227	29.2	9.6	79	28	107	67.0	64.2	67.0	34.5	51.4	3,053	2,045	1,052	18.1
231	30.1	10.1	79	30	109	66.4	61.6	63.6	32.2	50.6	1,415	900	455	7.8
232	22.0	7.7	77	32	109	64.9	77.8	60.1	30.7	51.1	1,844	1,109	567	9.8
234	38.4	13.3	79	33	112	65.5	56.0	.....	.....	.....	.....	.....	983	17.0
234	21.3	7.8	77	32	109	63.1	72.1	57.6	30.7	53.3	3,444	1,984	1,057	18.2
235	24.6	8.6	77	32	109	65.1	62.2	66.0	34.2	51.8	3,213	2,120	1,098	18.9
329	33.7	10.8	86	26	112	69.4	73.2	.....	.....	.....	.....	.....	1,125	19.4
343	44.0	13.0	86	26	112	70.5	91.4	.....	.....	.....	.....	.....	865	14.9
344	58.7	18.0	86	26	112	69.3	58.1	.....	.....	.....	.....	.....	480	8.3
345	20.0	8.1	79	33	112	59.7	62.7	.....	.....	.....	.....	.....	1,215	20.9
346	14.9	6.6	76	36	112	55.6	77.8	.....	.....	.....	.....	.....	1,010	17.4
364	16.9	7.4	77	35	112	56.1	66.5	.....	.....	.....	.....	.....	1,259	21.7
381	7.1	3.1	80	35	115	55.5	77.6	.....	.....	.....	.....	.....	1,687	29.1
382	14.5	5.7	85	30	115	60.4	77.6	.....	.....	.....	.....	.....	1,473	25.4
Average	26.3	9.4	79.8	31.4	111.3	63.5	69.2	62.9	32.9	52.2	2,849	1,795	1,037	17.8
1911:														
77	27.9	10.0	75	37	112	64.3	84.8	54.6	31.2	57.1	5,230	2,860	1,636	28.2
223–6	28.6	11.1	74	37	111	61.1	83.6	54.4	31.1	57.2	4,540	2,470	1,413	24.4
224	33.9	12.3	74	38	111	63.7	78.9	53.4	31.9	59.7	4,290	2,290	1,369	23.6
227	33.4	12.0	74	38	111	64.1	78.5	56.0	36.6	64.5	4,527	2,537	1,637	28.2
231	30.0	10.3	74	38	111	65.1	82.6	52.1	33.9	65.0	5,042	2,632	1,713	29.5
232	25.0	9.5	74	38	111	62.2	89.4	54.6	34.5	63.1	5,050	2,760	1,744	30.1
234	24.1	9.0	74	38	111	62.8	86.0	56.2	34.9	62.2	5,527	3,107	1,932	33.3
234	21.6	9.0	74	38	111	58.6	85.3	56.4	36.6	64.8	5,230	2,960	1,920	33.1
235	19.5	7.3	74	38	111	62.7	90.0	60.9	37.7	61.9	6,042	3,682	2,280	39.3
329	18.5	8.2	74	38	111	55.7	86.2	55.1	35.5	64.5	5,035	2,775	1,792	30.8
343	21.0	8.6	74	38	111	58.7	83.1	61.0	33.2	60.8	5,235	3,195	1,942	33.5
344	20.0	7.7	74	38	111	61.3	80.3	56.6	34.4	60.7	5,680	3,220	1,954	33.7
345	16.0	6.5	74	38	111	59.2	91.2	57.8	37.8	65.4	5,529	3,195	2,091	34.3
346	14.4	5.8	74	38	111	59.5	94.6	59.0	44.8	56.1	5,020	2,960	2,225	38.4
364	12.8	5.0	74	38	111	61.3	96.5	56.6	35.0	61.7	6,042	3,422	2,116	36.5
381	13.2	4.5	74	38	111	65.8	97.4	57.4	34.3	61.8	6,160	3,540	2,114	36.4
382	14.3	5.2	76	36	111	63.4	96.1	51.0	30.5	59.1	6,455	3,335	1,790	30.9
468	12.3	5.2	74	36	111	58.9	95.1	59.7	35.1	58.9	5,867	3,507	2,077	35.8
469	11.4	4.7	76	36	111	58.5	98.0	53.6	30.8	57.6	6,307	3,367	1,942	33.5
Average	20.9	7.2	74.2	37.5	111	61.4	88.3	56.1	34.7	61.2	5,412	3,043	1,878	32.3

TABLE VI.—*Agronomic data for standard milo grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Heads in crop.	Seed in—		Yields per acre.			
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.				Crop.	Heads.	Total crop.	Heads.	Seed.	
1912:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs.*	*Bus.*
77	7.1	3.3	72	35	107	52.9	97.5	54.9	34.7	63.1	5,360	2,945	1,861	32.1
223–6	8.5	3.6	72	35	107	57.0	96.5	49.5	26.9	54.2	5,090	2,523	1,370	23.6
224	8.9	3.5	72	35	107	61.2	95.6	51.8	28.3	58.3	5,290	2,743	1,499	25.8
227	7.5	3.5	72	35	107	53.6	99.0	56.5	34.1	60.3	4,920	2,783	1,679	29.0
231	7.2	3.4	72	35	107	53.1	97.0	54.8	31.8	58.1	5,460	2,992	1,739	29.7
232	6.5	3.5	72	35	107	47.1	99.0	55.4	33.4	60.2	5,740	3,185	1,919	33.0
234	6.3	3.4	72	35	107	46.1	98.1	54.7	31.1	56.8	4,330	2,371	1,349	23.3
234	7.1	3.6	75	32	107	50.1	98.0	53.0	25.6	52.9	4,020	2,134	1,130	19.5
235	6.6	3.1	75	32	107	52.4	99.0	.....	21.8	.....	3,152	.....	688	11.9
329	7.0	4.4	75	32	107	37.0	99.0	.....	31.7	.....	2,995	.....	951	16.4
343	7.3	3.5	75	32	107	52.0	98.1	.....	29.4	.....	3,635	.....	1,071	18.5
344	8.3	3.7	75	32	107	55.1	97.5	.....	33.3	.....	3,635	.....	1,210	20.9
346	6.3	3.5	75	32	107	44.5	98.2	.....	28.0	.....	3,243	.....	109	15.7
364	7.3	3.5	75	32	107	52.2	98.0	.....	25.5	.....	2,973	.....	759	13.1
381	7.3	3.3	90	[a] 17	107	54.3	96.5	.....	13.1	.....	1,571	.....	207	3.6
468	6.1	3.5	90	[a] 17	107	43.0	94.0	.....	6.1	.....	1,410	.....	87	1.5
469	7.3	3.5	90	[a] 17	107	52.0	98.0	.....	13.4	.....	2,130	.....	287	5.0
Average	7.2	3.5	76.3	30.5	107	50.7	97.5	53.8	26.3	57.9	3,821	2,709	1,101	19.0
1913:														
77	6.3	3.6	71	31	102	43.4	.....	.....	.....	.....	.....	.....	.....	.....
223–6	5.6	3.6	71	31	102	35.1	.....	.....	.....	.....	.....	.....	.....	.....
224	6.5	3.6	71	31	102	45.0	.....	.....	.....	.....	.....	.....	.....	.....
227	5.7	3.6	71	31	102	36.5	.....	.....	.....	.....	.....	.....	.....	.....
231	5.3	3.3	71	31	102	36.5	.....	.....	.....	.....	.....	.....	.....	.....
232	5.7	3.4	71	31	102	39.8	.....	.....	.....	.....	.....	.....	.....	.....
234	5.5	3.6	71	31	102	34.2	.....	.....	.....	.....	.....	.....	.....	.....
234	5.7	3.9	71	31	102	32.8	.....	.....	.....	.....	.....	.....	.....	.....
235	5.4	3.8	71	31	102	30.5	.....	.....	.....	.....	.....	.....	.....	.....
329	5.7	4.3	71	31	102	24.7	.....	.....	.....	.....	.....	.....	.....	.....
343	5.9	4.0	71	31	102	32.4	.....	.....	.....	.....	.....	.....	.....	.....
344	5.8	3.2	71	31	102	47.4	.....	.....	.....	.....	.....	.....	.....	.....
346	5.4	3.4	71	31	102	37.4	.....	.....	.....	.....	.....	.....	.....	.....
364	4.9	3.3	71	31	102	27.9	.....	.....	.....	.....	.....	.....	.....	.....
381	4.4	3.0	71	31	102	32.6	.....	.....	.....	.....	.....	.....	.....	.....
468	6.2	3.7	71	31	102	40.5	.....	.....	.....	.....	.....	.....	.....	.....
469	5.7	3.5	71	31	102	39.5	.....	.....	.....	.....	.....	.....	.....	.....
505	9.5	4.2	71	31	102	55.4	.....	.....	.....	.....	.....	.....	.....	.....
Average	5.8	3.6	71	31	102	37.3	.....	.....	.....	.....	.....	.....	.....	.....
1914:														
77	13.0	5.1	68	23	91	60.6	97.8	.....	11.7	.....	4,120	.....	480	8.3
223	13.5	5.5	68	23	91	59.6	99.0	.....	17.3	.....	4,280	.....	740	12.8
232	12.3	5.0	68	23	91	59.4	98.7	.....	16.8	.....	3,680	.....	620	10.7
234	12.1	4.3	68	23	91	64.0	99.1	.....	19.6	.....	4,400	.....	860	14.8
235	13.9	5.1	68	23	91	63.6	99.8	.....	13.2	.....	3,800	.....	500	8.4
Average	13.0	5.0	68	23	91	61.4	98.9	.....	15.7	.....	4,056	.....	640	11.0
1915:														
77	15.1	4.8	75	44	119	67.9	90.0	45.0	31.9	70.9	10,220	4,600	3,260	56.2
223	16.0	5.4	75	44	119	66.0	90.0	49.4	43.8	88.7	8,580	4,240	3,760	64.8
232	13.2	4.6	75	44	119	65.1	95.5	43.5	35.1	80.5	9,920	4,320	3,480	60.0
234	16.2	5.1	75	44	119	65.1	91.8	50.1	40.5	80.9	8,380	4,200	3,400	58.6
235	17.8	5.3	75	44	119	69.3	84.7	50.1	41.9	83.7	9,340	4,680	3,920	67.6
Average	15.7	5.1	75	44	119	66.7	90.4	47.6	38.6	80.9	9,288	4,408	3,564	61.4
1916:														
77	6.5	3.4	82	32	114	46.9	96.4	.....	11.9	.....	3,180	.....	380	6.6
223	7.0	3.9	82	32	114	44.0	93.7	.....	12.3	.....	3,580	.....	440	7.6
232	7.9	4.3	82	32	114	46.2	98.6	.....	11.9	.....	3,200	.....	380	6.6
234	7.3	3.8	83	31	114	47.6	95.6	.....	13.5	.....	2,960	.....	400	6.9
235	8.2	4.2	83	31	114	49.2	94.6	.....	15.8	.....	2,660	.....	420	7.2
Average	7.4	3.9	82.4	31.6	114	46.8	95.8	.....	13.1	.....	3,116	.....	404	7.0

[a] Plants killed by drought at this stage.

MILO.

The crop now grown commercially under the name of milo in the southern half of the Great Plains area is a descendant of the old milo, or "Giant milo," which was the original grain-sorghum crop of Texas. It has been considerably improved by the writers through selection for lower stature, earliness, and more uniformly erect heads. The number of different lots and selections under experiment has varied from as many as 19 in the year 1911 to only 5 during each of the last three years. The different lots vary little among themselves, as will be seen by comparing their average performances in Tables VI and VII. The total number of plats grown in the 9-year period was 107. Plats of milo and Dwarf milo are shown in figure 4.

A study of Table VI will show that, under fairly favorable conditions, when acre yields run from 18 to 40 bushels, as in 1908 and 1910,

FIG. 4.—Milo (right) and Dwarf milo (left) in plats at the Amarillo Cereal Field Station, August 30, 1911.

the average vegetative period of milo covers about 75 days. Under varying seasonal conditions it has ranged from as few as 68 days, in 1914, to as many as 82 days, in 1916. Drought occurring very early in the vegetative period results in slower growth and consequent prolongation of this period. This is seen in the seasons of 1910 and 1916. The apparent shortening of the vegetative period in 1914 was due to the fact that only a few early heads appeared, further development being checked by drought.

The ripening period of milo usually covers a little less than 30 days, as in the fairly normal season of 1908. It was shortened to only 23 days by the droughty conditions prevailing in 1914, the year in which only a few heads were produced. The ripening period may be prolonged, however, by conditions favorable to good yields. In 1911, for instance, the average duration of this period was 37.5 days, owing apparently to heavy rains just at the time of heading, as this was followed by dry and very hot weather throughout the ripening period. The average acre yield was 32.3 bushels. In 1915 the extremely prolonged ripening period of 44 days is correlated with

very cool, wet weather during the last three weeks of August, which was coincident with the first half of this period. The duration of the total growing period is about 105 to 110 days under Panhandle conditions. The shortest duration of the growing period was 91 days, in 1914, and the longest was 119 days, in 1915. The first was a dry season, marked by much reduced yields; the second a very wet season in which enormous yields were obtained.

The average row space intended for each plant of milo under Panhandle conditions is about 6.5 inches. Approximately this spacing has been obtained three times in the 9-year period, in the years 1912, 1913, and 1916. In the four years, 1908, 1909, 1914, and 1915, the spacing has varied between 9 and 16 inches, while in the other two years, 1910 and 1911, the stands obtained were very thin, the plants being 26.3 and 20.9 inches apart, respectively, in the two years. The average spacing of plants during the nine years has been 13.7 inches. The stands vary somewhat with the conditions at sowing time. Either a cold, wet spring or an extremely dry soil may reduce germination and consequent stand. Dry soil was the cause in 1910, but the exact cause in 1911 is not known, as the stands of Dwarf milo and Blackhull kafir were not markedly reduced that year.

The average stalk space is determined by conditions occurring during the progress of the early vegetative period and influencing the production of suckers. The average space in inches per stalk varies less than the space per plant, which shows the adaptation of these plants to equalize stand by means of tillering. The average stalk space in all plats in the nine years has been 5.7 inches, and only once has it appreciably exceeded 7 inches. This exception was in the year 1910, when the same drought that lowered germination also inhibited excessive tillering. The percentage of suckers in the total number of stalks varied from 37.3 in 1913, when a thick stand was accompanied by a dry growing season, to 66.7 per cent in 1915, when a fairly thin stand and excessive moisture both conduced to abundant tillering. In five out of the nine years, more than half the total stalks were suckers. In three of these years the yields were below normal. In the 9-year period 52.3 per cent of the total number of stalks were suckers. It is a question whether the free tillering of milo is wholly an advantage. Were it less pronounced the crop probably could make better yields in seasons of deficient moisture. The average height of milo under conditions obtaining in the Panhandle is about 4 feet.

The average of erect heads in milo in eight years was 86.9 per cent. Practically no heads were produced in 1913. The lowest average was 61 per cent, in 1908. In four of the eight years more

than 95 per cent of the heads were erect. The proportion of erect heads is influenced by the vigor of the plants at and after heading time. A low percentage of erect heads is correlated with good rains in the first half of August in 1908 and 1910, but not in 1914, when a drought in July had weakened the plants too much to permit response to the improved conditions.

Milo has made a very good average yield, 22.7 bushels of 58 pounds each per acre, in the 9-year period under consideration. The average is based on the yields from no less than 107 plats in the nine years. Table VII contains the annual and average acre yields of all lots grown. According to the figures in Tables VI and VII, the lowest average annual acre yields have been 0 in 1913, 6 bushels in 1909, and 7 bushels in 1916. The highest have been 61.4 bushels in 1915, 35.4 in 1908, and 32.3 bushels in 1911. The nine annual yields may be classified as one failure, three poor, two fair, two good, and one excellent. This probably is not far from what may be expected to occur in any period of similar duration. The 9-year average acre yields of the three lots grown during that period were 22.9, 22.4, and 20.5 bushels, respectively.

TABLE VII.—*Annual and average acre yields of all lots of standard milo grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

C. I. No.	Annual yields (bushels).									Average yields.				
	1908	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	6 years, 1908 to 1913.	8 years, 1909 to 1916.	9 years, 1908 to 1916.	
										Bus.	*Bus.*	*Bus.*	*Bus.*	*Cwt.*
77	.....	4.8	19.0	28.2	32.1	0	8.3	56.2	6.6	19.8	.....	19.4	.....	.....
223	37.4	16.5	18.8	24.4	23.6	0	12.8	64.8	7.6	16.7	20.1	21.1	22.9	13.3
224	45.0	[a]7.6	19.2	23.6	25.8	0	.....	.....	.....	17.2	20.0	.....	.....	.....
227	29.6	.....	18.1	28.2	29.0	0	.....	.....	.....	18.8	.....	.....	.....	.....
229	30.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
230	33.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
231	35.6	1.4	7.8	29.5	29.7	0	.....	.....	.....	16.7	17.3	.....	.....	.....
232	30.4	3.6	9.8	30.1	33.0	0	10.7	60.0	6.6	18.2	17.8	19.2	20.5	11.0
234	43.2	[b]5.8	[a]17.6	[a]33.2	[a]21.4	0	14.8	58.6	6.9	18.1	20.2	19.8	22.4	13.2
235	.....	1.1	18.9	39.3	11.9	0	8.4	67.6	7.2	17.5	.....	19.3	.....	.....
329	.....	.....	19.4	30.8	16.4	0	.....	.....	.....	16.5	.....	.....	.....	.....
331	33.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
343	.....	.....	14.9	33.5	18.5	0	.....	.....	.....	16.7	.....	.....	.....	.....
344	.....	.....	8.3	33.7	20.9	0	.....	.....	.....	15.7	.....	.....	.....	.....
345	.....	.....	20.9	34.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
346	.....	.....	17.4	38.4	15.7	0	.....	.....	.....	17.9	.....	.....	.....	.....
364	.....	.....	21.7	36.5	13.1	0	.....	.....	.....	17.8	.....	.....	.....	.....
381	.....	.....	29.1	36.4	3.6	0	.....	.....	.....	17.3	.....	.....	.....	.....
382	.....	.....	25.4	30.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
468	.....	.....	.....	35.9	1.5	0	.....	.....	.....	.....	.....	.....	.....	.....
469	.....	.....	.....	33.5	5.0	0	.....	.....	.....	.....	.....	.....	.....	.....
Average.	35.4	6.0	17.8	32.3	19.0	0	11.0	61.4	7.0	.....	.....	.....	.....	.....

[a] Average of two plats. [b] Average of five plats.

DWARF MILO.

Dwarf milo is essentially a dwarf form of the ordinary standard milo, differing chiefly in its lower stature. (See fig. 4.) Its origin is not known, but probably it was derived from a mutation of standard milo. Different selections of it have been grown throughout the 9-year period covered by these experiments. Considerable selection has been practiced by the writers to improve it in uniformity of height and ripening and to obtain more highly productive races. The number of selections under experiment increased from 5 in 1908 to 17 in 1910, decreasing thereafter to 5 again in each of the last three years. A total of 90 plats has been grown in the nine years. A plat grown in 1915 is shown in figure 5.

FIG. 5.—A plat of Dwarf milo, C. I. No. 332, at the Amarillo Cereal Field Station, September 14, 1915; yield, 72.8 bushels per acre.

Dwarf milo has about the same growth period as standard milo and therefore is affected by the same climatic conditions at about the same stages of development. A study of the data on vegetative and fruiting periods in Tables VI and VIII shows a close correspondence between its variations and those of standard milo. The average duration of the vegetative period of Dwarf milo in all years is 73.5 days, or about 2 days shorter than that of milo. The shortest average duration was 65 days, in 1914, and the longest was 79 days, in 1916. Both these extremes are lower than those of milo, but occur in the same years. The average duration of the fruiting period of all plats in the eight years in which the crop matured was 33.2 days, or 0.9 of a day longer than that of milo. The fruiting period was only 26 days in 1914, but was increased to 45 days in 1915, these periods being 3 days and 1 day longer, respectively, than those of milo in the same years.

TABLE VIII.—*Agronomic data for Dwarf milo grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Height of plants.	Seed in crop.	Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Total crop.	Seed.	
1908:	*Inches.*	*Inches.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
149A	8.4	4.0	76	29	105	52.4	73.8	3.5	.....	.....	2,190	37.8
149B	8.3	3.5	76	31	107	57.8	57.0	3.5	.....	.....	2,687	46.3
149C	9.0	3.8	76	29	105	57.7	58.7	3.5	.....	.....	2,543	43.8
332A	8.3	4.3	76	28	104	48.2	63.1	3.5	.....	.....	2,262	39.0
332B	9.1	4.1	76	28	104	54.9	.....	3.5	.....	.....	2,316	39.9
Average..	8.6	3.9	76	29	105	54.2	63.1	3.5	.....	.....	2,400	41.3
1909:												
149–5	11.4	7.5	73	.....	.....	34.2	99.4	.....	.....	.....	.....	10.2
149–6	12.1	9.8	73	.....	.....	23.1	99.5	.....	.....	.....	.....	7.9
149	11.7	7.7	70	.....	.....	33.3	99.4	.....	.....	.....	.....	19.1
236	13.5	7.2	78	.....	.....	46.7	99.3	.....	.....	.....	.....	5.8
236	12.2	6.5	74	.....	.....	46.6	98.8	.....	.....	.....	.....	3.2
236	8.7	4.8	73	.....	.....	44.8	99.4	.....	.....	.....	.....	6.5
332	11.0	7.7	73	.....	.....	30.0	99.4	.....	.....	.....	.....	10.0
332	10.8	7.7	73	.....	.....	28.7	99.2	.....	.....	.....	.....	10.6
332	13.1	7.2	70	.....	.....	45.0	98.8	.....	.....	.....	.....	23.2
332	14.9	9.0	70	.....	.....	39.6	99.4	.....	.....	.....	.....	13.4
Average..	11.8	7.3	72.7	.....	.....	37.2	99.3	.....	.....	.....	.....	11.0
1910:												
149–5	22.8	8.0	77	35	112	66.0	67.6	2.5	39.9	2,898	1,156	19.9
149–6	25.3	8.1	79	33	112	68.1	63.8	2.7	39.8	3,140	1,251	21.6
149–6	20.9	7.7	79	33	112	63.3	69.7	2.5	38.7	3,140	1,216	21.0
184	25.7	8.3	77	35	112	68.4	63.8	2.5	40.9	2,724	1,115	19.2
236	26.1	8.1	77	35	112	69.1	70.0	2.7	38.7	2,786	1,078	18.6
332A	33.2	11.1	79	33	112	66.5	57.6	2.7	41.7	2,507	1,046	18.0
332B	19.2	6.7	79	33	112	64.8	67.0	2.7	38.6	2,862	1,106	19.1
347	18.1	7.3	76	36	112	59.8	72.3	3.0	.....	.....	1,055	18.2
348	18.0	7.0	76	36	112	60.9	64.4	2.7	.....	.....	1,195	20.6
357	17.8	6.8	79	33	112	61.7	64.6	2.7	.....	.....	1,035	17.8
358	12.3	6.0	76	36	112	51.0	75.7	2.7	.....	.....	1,045	18.0
359	11.1	5.8	76	36	112	47.7	76.4	2.7	.....	.....	1,158	20.0
360	12.1	6.0	79	33	112	50.3	73.4	2.5	.....	.....	961	16.6
361	10.1	4.9	77	35	112	51.9	79.1	2.7	.....	.....	1,127	19.4
362	14.1	5.9	76	36	112	58.0	76.2	3.2	.....	.....	1,212	20.9
363	16.9	6.6	79	33	112	60.6	73.4	2.5	.....	.....	1,061	18.3
368	16.8	6.6	77	35	112	60.9	72.3	2.7	.....	.....	932	16.1
Average..	18.8	7.1	77.5	34.4	112	60.5	69.8	2.7	39.8	2,865	1,103	19.0
1911:												
149–5	8.9	3.7	73	37	110	58.5	98.5	5.0	31.9	6,525	2,085	36.0
149–6	11.4	3.9	73	37	110	65.4	98.4	4.7	32.9	6,587	2,172	37.5
184	10.6	4.0	73	37	110	62.2	97.7	5.0	34.3	6,294	2,160	37.3
236	10.8	4.1	73	37	110	61.7	97.4	4.7	34.8	6,347	2,212	38.1
332	10.5	4.2	72	37	109	59.8	98.1	4.7	35.3	6,138	2,167	37.4
347	10.8	4.3	72	37	109	60.2	98.8	4.7	35.9	6,294	2,260	38.9
348	9.5	4.4	74	35	109	53.7	98.4	4.7	37.6	5,955	2,240	38.6
357	11.2	4.0	74	35	109	63.0	97.2	4.7	39.1	6,317	2,472	42.6
358	11.7	4.4	74	35	109	62.6	97.5	4.7	37.7	6,080	2,294	39.6
359	10.9	4.5	74	35	109	59.0	97.3	4.7	37.8	5,720	2,164	37.3
360	12.3	4.9	74	35	109	60.5	97.0	4.7	37.9	5,554	2,110	36.4
361	9.8	4.9	74	35	109	61.1	98.2	4.7	33.0	6,337	2,092	36.1
362	10.7	4.4	74	35	109	58.3	98.6	5.0	33.1	6,360	2,074	35.8
363	10.4	3.9	74	35	109	62.4	98.8	5.0	33.8	6,114	2,070	35.7
368	12.1	4.4	74	35	109	65.2	98.1	5.0	33.7	6,375	2,150	37.1
Average..	10.8	4.3	73.4	35.8	109.2	60.9	98.0	4.8	35.3	6,200	2,181	37.6
1912:												
149–5	6.4	3.4	75	32	107	46.9	97.8	2.5	30.6	1,982	608	10.5
149–6	7.3	3.5	75	32	107	52.0	96.4	2.5	35.0	2,653	929	16.0
184	5.9	3.2	75	32	107	46.2	98.3	2.5	33.3	2,571	858	14.8
236	4.5	2.8	78	29	107	38.1	98.6	2.5	28.4	2,283	649	11.2
332B	6.5	3.1	72	35	107	51.8	98.2	2.5	40.1	3,483	1,399	24.0
347	4.5	2.5	75	32	107	44.0	99.0	2.5	34.9	3,173	1,109	19.1

TABLE VIII.—*Agronomic data for Dwarf milo grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Height of plants.	Seed in crop.	Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Total crop.	Seed.	
1912—Contd.	*Inches.*	*Inches.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
348	5.8	3.2	75	32	107	44.9	98.1	2.5	40.3	3,693	1,489	25.7
357	5.9	3.2	72	35	107	45.1	95.6	2.5	43.4	3,933	1,709	29.5
358	6.0	3.5	74	32	106	41.0	98.0	2.8	45.3	4,035	1,831	31.6
359	5.7	3.4	71	35	106	39.5	98.6	2.8	45.9	4,373	2,009	34.6
360	5.4	3.4	74	32	106	36.3	98.5	2.8	36.8	3,493	1,289	22.2
361	8.6	3.4	74	32	106	60.1	97.2	2.8	42.6	3,213	1,369	23.6
362	7.3	3.3	74	32	106	55.5	97.6	2.8	40.8	3,252	1,328	22.9
363	7.3	3.4	74	32	106	53.5	97.6	2.8	43.1	3,453	1,489	25.7
368	6.8	3.2	74	32	106	53.2	98.0	2.8	39.7	3,693	1,469	25.3
487	6.2	3.3	74	32	106	46.8	98.0	2.8	43.1	3,453	1,489	25.7
Average	6.3	3.2	74.1	32.3	106.5	47.0	97.8	2.6	38.9	3,296	1,314	22.6
1913:												
149–5	4.4	3.2	70	30	100	27.1	.....	1.7	.....	.....	.....	.....
149–6	4.5	3.2	70	30	100	28.2	.....	1.7	.....	.....	.....	.....
184	4.9	3.4	70	30	100	29.9	.....	1.7	.....	.....	.....	.....
236	4.8	3.1	70	30	100	34.6	.....	1.7	.....	.....	.....	.....
332B	4.9	3.4	70	30	100	30.4	.....	1.7	.....	.....	.....	.....
347	4.7	3.4	70	30	100	28.1	.....	1.7	.....	.....	.....	.....
348	4.9	3.3	70	30	100	32.4	.....	1.7	.....	.....	.....	.....
357	4.7	3.4	70	30	100	29.1	.....	1.7	.....	.....	.....	.....
358	4.5	3.4	70	30	100	24.5	.....	1.7	.....	.....	.....	.....
359	5.6	3.7	70	30	100	34.8	.....	1.7	.....	.....	.....	.....
360	4.6	3.2	70	30	100	31.4	.....	1.7	.....	.....	.....	.....
361	5.1	3.5	70	30	100	31.4	.....	1.7	.....	.....	.....	.....
362	4.6	3.3	70	30	100	27.4	.....	1.7	.....	.....	.....	.....
363	4.4	3.2	70	30	100	25.8	.....	1.7	.....	.....	.....	.....
368	5.0	3.5	70	30	100	30.6	.....	1.7	.....	.....	.....	.....
487	4.5	3.3	70	30	100	27.0	.....	1.7	.....	.....	.....	.....
504	4.9	3.3	70	30	100	31.2	.....	1.7	.....	.....	.....	.....
Average	4.8	3.3	70	30	100	29.6	.....	1.7	.....	.....	.....	.....
1914:												
149–5	9.2	4.1	65	26	91	55.4	99.2	3.0	30.2	5,760	1,740	30.0
236	10.0	4.2	65	26	91	58.4	99.6	3.0	32.5	5,600	1,800	31.0
332	7.1	3.8	65	26	91	47.2	99.8	3.0	32.4	5,440	1,760	30.3
347	9.1	3.8	65	26	91	58.6	99.7	3.0	29.5	5,360	1,580	27.1
359	11.4	4.5	65	26	91	60.6	99.4	2.8	24.7	3,800	940	16.2
Average	9.4	4.1	65	26	91	56.0	99.5	3.0	29.8	5,192	1,564	26.9
1915:												
149	13.2	4.5	74	45	119	66.0	87.2	4.5	31.9	.....	.....	.....
236	12.6	4.3	74	45	119	65.9	89.1	4.5	43.8	12,480	3,640	62.7
332	12.1	4.5	74	45	119	63.0	91.6	4.5	35.1	10,380	4,080	70.3
347	13.2	3.9	74	45	119	70.4	94.5	4.5	40.5	8,340	4,200	72.4
359	14.1	3.5	74	45	119	67.9	92.4	4.5	41.9	9,400	3,960	68.3
Average	13.0	4.1	74	45	119	66.6	91.0	4.5	38.6	10,150	3,970	68.4
1916:												
149	7.0	3.5	78	36	114	50.3	99.1	2.3	20.9	2,100	440	7.6
236	7.3	3.7	78	36	114	49.8	98.6	2.3	21.7	1,840	400	6.9
332	7.7	3.7	78	36	114	52.6	100.0	2.3	27.2	2,060	560	9.7
347	7.6	3.7	80	33	113	50.7	99.4	2.3	26.5	2,260	600	10.3
359	7.2	3.7	82	32	114	48.9	99.4	2.3	22.3	2,240	500	8.6
Average	7.4	3.7	79	34	114	50.5	99.3	2.3	23.7	2,100	500	8.6

The length of the total growing period, averaged for all plats in all eight years, is practically identical for both milo and Dwarf milo, being 106.5 and 106.9 days, respectively. The shortest growing period recorded was 91 days, in 1914, and the longest 119 days, in 1915. The growing periods of milo were of exactly the same dura-

tion as those of Dwarf milo in these two years. The total growing period of both varieties was made to appear very short in 1914, owing to the drought, which inhibited the production of all but a few early heads.

In 1915 the vegetative period was about normal and the fruiting period greatly lengthened in both, and in 1916 both periods were somewhat prolonged in both varieties.

Table VIII shows that the average drill-row space per plant of Dwarf milo in all plats during the whole nine years has been 10.3 inches. The variation from year to year has not been quite so great as it was in the milo. The annual averages range from 4.8 inches in 1913 to 18.8 inches in 1910. The next poorest stand was in 1915, when each plant had 13 inches of space. Milo had a stand of one plant to each 15.7 inches in the same year. In 1911, when milo had only one plant to each 20.9 inches, Dwarf milo had one plant to each 10.8 inches, or nearly twice the stand of milo. No reason for the difference is known.

The average stalk space in the total of 90 plats grown in the nine years was 4.7 inches, compared with 5.7 inches for all milo plats. The average plant space in the same period was 10.3 inches for Dwarf milo and 13.7 inches for milo. These bear about the same proportion to each other as the respective stalk spaces. Of all Dwarf milo stalks in all years, 49.5 per cent were suckers, while 52.3 per cent of the milo stalks were suckers under the same conditions. In short, the milo plants on the average had 3.4 inches, or about 35 per cent, more space than the Dwarf milo plants, but produced only about 5.6 per cent more suckers. In the different years the stalk space varied from 3.2 inches, in 1912, to 7.3 inches, in 1909. It is of interest that the total failure of 1913, the average acre yield of 41.3 bushels in 1908, and the bumper acre yield of 68.4 bushels in 1915 should be associated with stands of one stalk to each 3.3, 3.9, and 4.1 inches of space, respectively. In the latter year exactly two-thirds of the stalks were suckers. In other words, with a stand of one plant to each 13 inches each stalk produced two suckers on the average under the influence of the very favorable wet season.

On all plats in all years the average percentage of erect heads was 89.8 per cent, compared with 86.9 in milo. In five out of the eight years in which heads were formed, more than 97 per cent were erect. In the favorable season of 1908, only 63.1 per cent were erect, while in the very favorable wet season of 1915, 91 per cent were erect. This increased erectness in 1915 probably was due to the continued selection for erect heads and the effect of the extremely heavy seed crop in suppressing what otherwise would have been excessive vegetative vigor.

The average height of Dwarf milo in all 90 plats in all nine years was 3 feet, compared with an average of 4 feet for milo. There was an enormous variation in average height from year to year. For instance, in 1916 the average height was only 2.3 feet, and in 1912 but 2.6 feet. In 1915, however, under the influence of abundant rainfall, it rose to 4.5 feet, and in 1911 to 4.8 feet. The average height of 1.7 feet, recorded in 1913, included many stalks which bore no heads and therefore had not attained full height.

The most important character of Dwarf milo is its outstanding ability to produce good yields, as shown in Tables IX and XVIII. The average acre yield from all the 90 plats grown in the nine years has been 26.2 bushels. Under the same conditions, the average acre yield from 107 plats of milo was 22.7 bushels. The lowest average yield recorded, except the complete failure of 1913, is 8.6 bushels, in 1916. The highest is 68.4 bushels, in 1915. In the same years milo yielded 7 and 61.4 bushels, respectively. The yields of this variety obtained during the nine years of the experiment may be classified as follows: One failure, two poor, three fair, two good, and one superexcellent.

TABLE IX.—*Annual and average acre yields of all lots of Dwarf milo grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

C. I. No.	Annual yields (bushels).									Average yields.				
	1908	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	7 years, 1910 to 1916.	8 years, 1909 to 1916.	9 years, 1908 to 1916.	
										Bus.	*Bus.*	*Bus.*	*Bus.*	*Cwt.*
149	[a]42.6	[a]12.4	[a]20.8	[b]36.8	[b]13.3	0	30.0	74.1	7.6	17.7	26.1	24.4	26.4	15.3
184	.....	.....	19.2	37.3	14.8	0	.....	.....	.....	17.8	.....	.....	.....	.....
236	.....	[a]5.2	18.6	38.1	11.2	0	31.0	62.7	6.9	16.9	24.1	21.7	.....	.....
332	[b]39.5	[c]14.3	[b]18.6	37.4	24.0	0	30.3	70.3	9.7	20.0	27.2	25.6	27.1	15.7
347	.....	.....	18.2	38.9	19.1	0	27.1	72.4	10.3	19.1	26.6	.....	.....	.....
348	.....	.....	20.6	38.6	25.7	0	.....	.....	.....	21.2	.....	.....	.....	.....
357	.....	.....	17.8	42.6	29.5	0	.....	.....	.....	22.5	.....	.....	.....	.....
358	.....	.....	18.0	39.6	31.6	0	.....	.....	.....	22.3	.....	.....	.....	.....
359	.....	.....	20.0	37.3	34.6	0	16.2	68.3	8.6	22.9	26.4	.....	.....	.....
360	.....	.....	16.6	36.4	22.2	0	.....	.....	.....	18.8	.....	.....	.....	.....
361	.....	.....	19.4	36.1	23.6	0	.....	.....	.....	19.8	.....	.....	.....	.....
362	.....	.....	20.9	35.8	22.9	0	.....	.....	.....	19.9	.....	.....	.....	.....
363	.....	.....	18.3	35.7	25.7	0	.....	.....	.....	19.9	.....	.....	.....	.....
368	.....	.....	16.1	37.1	25.3	0	.....	.....	.....	19.6	.....	.....	.....	.....

[a] Average yield from three plats. [b] Average yield from two plats. [c] Average yield from four plats.

The 9-year average acre yields of two lots grown during that period are 27.1 and 26.4 bushels, respectively. The yield of the best one is 4.2 bushels more than the yield of the best milo in the same period, as shown in Table XVIII. In figure 6 the annual yields of

the best race (C. I. No. 332) during the nine years from 1908 to 1916, inclusive, are shown in graphic form, together with the seasonal (May to August) and annual precipitation during the same period.

ALBA, OR WHITE, MILO.

The variety Alba, or White, milo, is an exact counterpart of the ordinary standard milo except in the color of the seed, which is white instead of brown. The early history of this variety is not known. It probably was introduced about 25 or 30 years ago. It was found under cultivation in scattered localities in western Texas, in 1909, during an extensive reconnaissance made by the senior writer. It has since been found sparingly in Oklahoma. Five different lots were obtained in 1909 and included in the experiments in 1910.

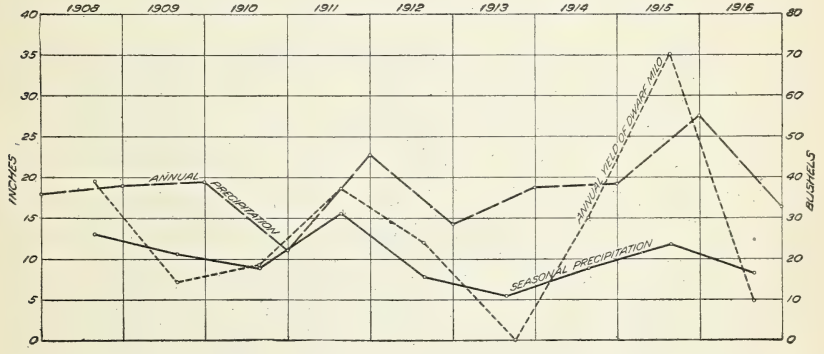

FIG. 6.—Diagram showing the seasonal (May to August) and annual precipitation, in inches, and the acre yield of Dwarf milo (C. I. No. 332), in bushels, at the Amarillo Cereal Field Station in each of the nine years from 1908 to 1916, inclusive.

The number was increased to nine in 1912, but during the last three seasons only two lots have been grown. A total of 34 plats have been grown in the seven years. The results obtained are given in Tables X and XI. The Alba milo is so similar to milo in its adaptations and reactions to environment that extended comment upon the results seems unnecessary.

The extremely prolonged ripening period in 1910 was due to the very thin stand, which permitted free tillering, there being 70.8 per cent of suckers in the total number of stalks. The many late-appearing suckers matured slowly, thus prolonging the ripening an extra 10 days. Only 60.7 per cent of erect heads resulted. The thin stand was due, in turn, to the immature condition of part of the seed obtained in 1909, as the exploring trip was made before these crops were ripe.

TABLE X.—*Agronomic data for White milo grown at the Amarillo Cereal Field Station during the 7-year period from 1910 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1910:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Per cent.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
352	30.8	9.9	78	42	120	67.9	53.9	4.0	62.3	35.2	57.0	2,760	1,720	16.9
353	40.6	12.5	78	43	121	68.9	56.7	3.7	.....	.....	.....	.....	.....	15.0
354	28.3	9.4	78	43	121	66.8	55.9	3.5	.....	.....	.....	.....	.....	14.6
365	27.2	7.9	78	43	121	70.9	51.8	3.7	63.1	34.4	49.8	3,250	2,049	17.6
367	96.6	19.8	86	36	122	79.5	85.3	5.0	51.4	25.3	48.1	2,199	1,129	9.6
Average.	44.7	11.9	79.6	41.4	121	70.8	60.7	3.9	58.9	31.6	51.6	2,736	1,632	14.7
1911:														
352	11.1	4.8	74	34	109	56.1	96.4	6.5	56.9	33.9	59.5	6,410	3,650	37.5
353	11.8	5.6	74	34	109	52.5	95.1	6.3	53.6	33.3	62.1	6,040	3,240	34.9
354	11.5	5.5	74	34	109	52.3	94.7	6.0	57.8	34.7	60.0	5,875	3,400	35.2
365	13.1	5.9	74	34	109	55.4	95.4	6.0	55.5	33.9	61.1	5,871	3,261	34.4
367	13.5	5.1	93	16	109	62.3	100.0	6.5	36.8	14.1	38.6	6,493	2,393	15.6
Average.	12.2	5.4	77.8	30.4	109	55.7	96.3	6.3	52.1	30.0	56.3	6,138	3,315	31.5
1912:														
352	7.9	3.9	77	29	106	50.4	98.5	3.3	.....	28.6	.....	3,203	.....	15.8
353	7.5	3.8	77	29	106	49.9	98.7	3.3	.....	31.6	.....	3,373	.....	18.4
354	7.3	3.5	77	29	106	51.9	94.4	3.3	.....	26.7	.....	3,553	.....	16.4
365	7.7	3.9	77	29	106	49.2	97.3	3.5	.....	27.1	.....	3,713	.....	19.1
367	9.9	3.6	89	36	125	63.6	99.5	4.0	.....	12.2	.....	4,793	.....	10.2
480	5.2	3.3	82	24	106	37.2	97.4	2.8	.....	26.2	.....	2,925	.....	13.2
481	7.4	3.6	82	24	106	51.1	90.8	2.8	.....	19.9	.....	2,638	.....	9.1
488	4.0	2.9	82	24	106	26.4	99.0	3.0	.....	14.1	.....	3,269	.....	7.8
499	12.5	5.1	82	24	106	59.0	93.7	3.0	.....	17.5	.....	2,138	.....	6.5
Average.	7.7	3.7	80.5	27.5	108	48.7	96.6	3.2	.....	22.8	.....	3,289	.....	12.9
1913:														
352	5.9	3.8	70	.....	.....	35.9	.....	1.7	.....	.....	.....	.....	.....	.....
353	5.4	3.7	79	.....	.....	31.0	.....	1.7	.....	.....	.....	.....	.....	.....
354	6.7	4.2	70	.....	.....	36.9	.....	1.7	.....	.....	.....	.....	.....	.....
365	6.7	4.5	70	.....	.....	32.9	.....	1.7	.....	.....	.....	.....	.....	.....
367	9.4	4.1	.....	.....	.....	56.1	.....	1.7	.....	.....	.....	.....	.....	.....
480	5.0	3.3	79	.....	.....	34.9	.....	1.7	.....	.....	.....	.....	.....	.....
481	5.9	3.4	70	.....	.....	42.4	.....	1.7	.....	.....	.....	.....	.....	.....
488	8.3	4.4	79	.....	.....	46.2	.....	1.7	.....	.....	.....	.....	.....	.....
499	6.3	4.3	70	.....	.....	31.4	.....	1.7	.....	.....	.....	.....	.....	.....
Average.	6.6	4.0	73.3	.....	.....	38.6	.....	1.7	.....	.....	.....	.....	.....	.....
1914:														
352	12.7	4.7	68	23	91	62.8	98.8	4.3	.....	14.9	.....	4,440	.....	11.4
480	16.1	5.6	68	23	91	65.3	98.4	4.0	.....	8.3	.....	4,320	.....	6.2
Average.	14.4	5.2	68	23	91	64.0	98.6	4.1	.....	11.6	.....	4,380	.....	8.8
1915:														
352	16.8	5.6	75	44	119	66.6	83.9	5.3	48.3	35.5	73.5	9,680	4,680	59.3
480	16.3	5.1	75	41	116	68.6	74.3	5.3	50.8	37.8	74.7	9,560	4,840	62.4
Average.	16.6	5.4	75	43	118	67.6	79.1	5.3	49.5	36.6	74.1	9,620	4,760	61.8
1916:														
352	7.7	3.9	82	31	113	48.7	98.1	3.3	.....	10.2	.....	2,740	.....	4.8
480	8.6	3.5	62	30	92	48.3	98.9	3.3	.....	28.5	.....	1,400	.....	6.9
Average.	8.1	3.7	72	31	102	48.5	98.5	3.3	.....	19.3	.....	2,070	.....	5.9

The yields obtained from all lots in all years are shown in Table XI. The average acre yield of Alba milo in the seven years from 1910 to 1916, inclusive, was about 20 bushels, or nearly 3 bushels less than

that of milo. In no year has the average yield of all lots of the Alba variety exceeded the average yield of all lots of standard milo. Likewise, the highest yielding Alba has never equaled the highest yielding milo. In 1915, the year of bumper yields, however, the average yield of the two lots of Alba equaled the average yield of the five lots of milo, being 61.8 and 61.4 bushels per acre, respectively. In short, Alba milo is almost identical with milo in all its adaptations, but so far is slightly below milo in yield. The annual and average yields of one strain are compared with those of the other milos and durras in Table XVIII.

TABLE XI.—*Annual and average acre yields of all lots of Alba, or White, milo grown at the Amarillo Cereal Field Station during periods of varying length in the seven years from 1910 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

C. I. No.	Annual yields (bushels).							Average yields.			
	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	5 years, 1912 to 1916.	7 years, 1910 to 1916.	
								Bus.	*Bus.*	*Bus.*	*Cwt.*
352	16.9	37.5	15.8	0	11.4	59.3	4.8	17.5	18.3	20.8	12.0
353	15.0	34.9	18.4	0	.....	.....	.....	17.1	.....	.....	.....
354	14.6	35.2	16.4	0	.....	.....	.....	16.0	.....	.....	.....
365	17.6	34.4	19.1	0	.....	.....	.....	17.8	.....	.....	.....
367	9.6	15.6	10.2	0	.....	.....	.....	8.8	.....	.....	.....
480	.....	.....	13.2	0	6.2	62.4	6.9	.....	17.5	.....	.....
481	.....	.....	9.1	0	.....	.....	.....	.....	.....	.....	.....
488	.....	.....	7.8	0	.....	.....	.....	.....	.....	.....	.....

FETERITA.

Feterita[1] is a variety of the milo group introduced from the British-Egyptian Sudan. It is similar to milo in most of the characters of the stalks and leaves. In height it averages about 5 feet under Panhandle conditions, or about 1 foot taller than milo. The head or spike is more elongated, elliptical rather than ovate in outline, somewhat less compact than that of milo, and always erect. The seeds are a chalky white, or sometimes bluish white, rather than a yellowish white or pale buff. The seeds also are softer than those of milo, and hence more likely to decay in a cold, wet soil. A plat of feterita grown at Amarillo, Tex., in 1915, is shown in figure 7.

One importation was received in time to be included in the experiments in the spring of 1908, while a second was added in 1914. Only 12 plats have been grown, therefore, in the 9-year period. The results obtained are shown in Table XII.

The total length of the growing period of feterita has varied greatly in the nine years. The average is about 107 days. In general, the responses of feterita have been about the same as those of milo to

[1] Vinall, H. N., and Ball, C. R. Feterita, a new variety of sorghum. *In* U. S. Dept. Agr., Bur. Plant Indus. Cir. 122, p. 25-32. 1913.

the same conditions. The shortest period recorded is 93 days, in 1914, and the longest 122 days, in 1912, though the total duration in 1910, 1915, and 1916 was between 115 and 119 days. In 1910 the vegetative and ripening periods were both prolonged, while in the last two years only the ripening period was extended. The reasons for these facts have been already stated under "Milo" and "Dwarf milo" and need not be repeated here.

TABLE XII.—*Agronomic data for feterita grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

C. I. No. and year.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
C. I. No. 182:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Perct.*	*Perct.*	*Feet.*	*Perct.*	*Perct.*	*Perct.*	*Lbs.*	*Lbs.*	*Bus.*
1908	10.0	4.4	71	31	102	56.0	.....	6.5	.....	.....	.....	.....	.....	40.2
1909	16.1	10.3	72	27	99	36.0	.....	.....	.....	.....	57.5	.....	.....	9.3
1910	37.3	9.3	80	36	116	75.1	100.0	5.5	73.6	33.3	45.2	2,570	1,891	14.7
1911	14.6	5.3	67	35	102	64.0	100.0	5.5	56.4	38.8	68.7	4,775	2,695	31.9
1912	12.2	4.3	76	46	122	64.5	85.9	4.3	63.5	37.5	59.0	3,780	2,403	24.5
1913	7.9	4.7	69	.....	.....	40.3	.....	.....	.....	.....	.....	.....	.....	.....
1914	11.8	4.9	60	29	89	58.3	63.6	4.5	.....	23.7	.....	4,600	.....	18.5
1915	25.0	7.3	68	51	119	70.6	100.0	5.3	.....	35.1	.....	8,600	.....	52.1
1916	8.2	4.2	67	46	113	48.6	48.8	3.0	.....	31.8	.....	2,640	.....	14.5
C. I. No. 567:														
1914	9.9	4.0	80	17	97	59.2	24.7	4.0	.....	10.6	.....	4,000	.....	7.3
1915	34.6	11.3	74	45	119	67.8	86.1	5.8	.....	41.4	.....	5,840	.....	41.7
1916	7.7	3.8	79	37	116	50.5	23.6	3.5	.....	16.4	.....	3,540	.....	10.0
Average:														
1914	10.8	4.4	70	23	93	58.7	44.3	4.3	.....	17.6	.....	4,300	.....	12.9
1915	29.8	9.3	71	48	119	69.0	95.5	5.5	.....	38.2	.....	7,220	.....	46.9
1916	7.9	4.0	73	42	115	49.5	36.2	3.3	.....	24.1	.....	3,090	.....	12.2

The average drill-row space per plant and per stalk in feterita is somewhat longer than in the case of milo. This is due chiefly to the softer seed and consequent poorer germination under unfavorable conditions, such as the dry spring weather in 1910 and the wet weather in 1915. In these two years the plant space was 37.3 and 29.8 inches, respectively, the widest spacing recorded for any variety in any year. The closest was 7.9 inches in 1913 and 1916.

The stalk space has varied only about half as widely, owing to the very free tillering of feterita. It has been more difficult to assign the proper limits to the vegetative and fruiting periods of feterita than to those of any of the other commercial varieties. This is due to the more uneven stands obtained and the greater variation in the number and percentage of suckers produced. Under dry spring conditions even a thin stand of feterita may head at an average height of only 3 or 3.5 feet. Under the influence of subsequent rains it may continue to produce suckers for some weeks, and these in turn continue to produce heads and to ripen seed. This condition represents really not one crop but two or three crops in succession

on the same plants. This also helps to explain some of the records of prolonged periods of growth or ripening.

There has been much popular approval of feterita as a supposedly more drought-resistant crop than either milo or Dwarf milo, based on its occasional production of small to fair yields where the milos have failed completely. In the observation of the writers this has been due to the thinner stands, which are normal with this variety. These give it an advantage over the milos in dry seasons, when tillering is largely inhibited. In only two years, 1909 and 1913, both years of drought, has the proportion of suckers dropped below 50 per cent, or one sucker to each original plant. In 1915 there were

FIG. 7.—A plat of feterita, C. I. No. 182, at the Amarillo Cereal Field Station, September 28, 1915; yield, 55.5 bushels per acre.

69 per cent and in 1910, 75.1 per cent of suckers, or an average of three fruiting suckers to each main stalk. These percentages are somewhat larger than those of milo in both cases.

The average acre yield of feterita (C. I. No. 182), in bushels of 58 pounds, has been 22.8 bushels in the 9-year period. This is approximately the same as the average acre yield of the best milo in the same period, but more than 4 bushels less than the average acre yield of the best Dwarf milo, as shown in Table XVIII. In two years, 1914 and 1916, however, this feterita has outyielded the best milo by quantities of 4 and 7 bushels, respectively. The lowest acre yield from this feterita was 9.3 bushels, in 1909, when the best milo made 16.5 bushels. The highest acre yield of this feterita was 52.1 bushels, in 1915, when the best lot of milo yielded 67.5 bushels. It

is thus evident that feterita can scarcely compete with milo as a producer of grain; and milo, it should be remembered, is consistently outyielded by Dwarf milo.

WHITE DURRA.

The durra subgroup differs from the milos chiefly in the broader and more hairy glumes, not transversely wrinkled, and the flatter seeds. Two durra varieties were introduced into California in 1874 under the names "White Egyptian corn" and "Brown Egyptian corn," it being reported that they had come from Egypt. They have since become known as White durra and Brown durra, respectively. Like the milos, they differ from each other only in the color of the seeds.

The durras are low-growing plants with dry stems and few leaves. The heads are ovate or oval, rather compact, and commonly recurved or pendent. The broad seeds are lenticular in shape and much more flattened than in the case of milo or feterita. Very similar forms, no doubt the progenitors of these, are still found in cultivation in North Africa and in western Asia under the Arabic general name Dari. The forms of Turkestan are taller, with much more compact heads, and are known there as Dzhugara, a name probably from the same root as jowar, the name used in India for sorghum.

The white form of durra was rather extensively grown in the early days of dry farming in Kansas under the name Jerusalem corn. The brown form never has been commercially important. There are real objections to these varieties as farm crops. Among them are the recurved heads, the easily shattering seed, and the covering of hairs on the glumes. The first makes harvesting difficult, the second causes heavy loss of seed in wind or storm, as well as in harvest, and the third is very irritating to workmen in thrashing. Careful selection has eliminated the pendent heads and Nos. 27 and 81 have heads completely erect The shattering habit and hairy glumes have not yielded to simple selection, and none of the many hybrids has been entirely satisfactory in other respects.

Nine different lots or races have been included in the experiments, seven being included at the start in 1908 and two having been added since. In the last three years all but one have been discarded, and that one has been retained chiefly for illustration and comparison. Of the nine lots tested, Nos. 27 and 81 are selections from the ordinary White durra found in the United States, while No. 283 is an unselected lot of the same. No. 129 represents the Dzhugara from Turkestan. No. 244 is a form with less compact heads, called Edra, from Arabia. Nos. 247 and 248 are from India and not closely related to any of the others. The results of these experiments are shown in Table XIII.

TABLE XIII.—*Agronomic data for White durra grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
27	7.1	4.2	68	28	96	40.8	.....	5.0	.....	.....	.....	.....	.....	31.6
81	8.6	5.3	63	30	93	38.3	.....	6.0	.....	.....	.....	.....	.....	35.7
129	.....	.....	75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
244	8.7	4.7	78	34	112	45.9	.....	.....	.....	.....	.....	.....	.....	.....
247	.....	.....	77	.....	.....	.....	.....	6.0	.....	.....	.....	.....	.....	.....
248	11.8	5.6	77	34	111	52.5	.....	5.0	.....	.....	.....	.....	.....	32.7
283	.....	.....	67	28	95	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average.	9.0	4.9	72	31	101	44.4	.....	5.5	.....	.....	.....	.....	.....	33.3
1909:														
27	11.3	11.1	64	31	95	1.7	.....	.....	.....	.....	50.4	.....	.....	12.4
81	12.9	11.8	64	31	95	8.5	.....	.....	.....	.....	41.1	.....	.....	7.7
244	13.2	8.9	77	24	101	33.3	.....	.....	.....	.....	66.9	.....	.....	21.2
248	11.9	9.3	93	33	126	21.8	.....	.....	.....	.....	63.0	.....	.....	7.0
Average.	12.3	10.3	74.5	29.7	104	16.3	.....	.....	.....	.....	55.3	.....	.....	12.1
1910:														
27	14.8	14.8	70	26	96	0	100.0	5.0	64.5	34.0	52.7	1,993	1,286	11.7
81	12.8	8.1	59	38	97	36.7	100.0	5.0	61.8	31.0	50.2	1,866	1,154	10.0
244	24.7	11.4	78	38	116	53.8	75.1	6.0	.....	.....	.....	.....	.....	8.8
248	47.9	15.0	95	32	127	68.6	47.9	4.5	.....	.....	.....	.....	.....	7.8
373	34.4	22.3	70	51	121	35.2	41.8	3.7	.....	.....	.....	.....	.....	.....
Average.	26.9	14.3	74	37	111	38.8	72.9	4.8	63.1	32.5	51.4	1,929	1,224	9.6
1911:														
27	8.3	7.9	64	38	102	5.1	100.0	6.5	59.8	39.8	66.5	4,582	2,742	31.5
81	12.8	10.0	64	38	102	22.1	100.0	6.0	44.7	27.6	61.8	5,539	2,479	26.4
Average.	10.5	8.9	64	38	102	13.6	100.0	6.2	52.2	33.7	64.1	5,060	2,610	28.9
1912:														
27	2.7	2.7	71	33	104	.....	95.2	4.0	47.4	24.0	50.7	3,440	1,630	14.3
81	4.7	4.5	71	33	104	5.0	94.6	4.3	65.8	41.1	62.5	3,420	2,252	24.3
434	5.2	5.2	76	28	104	.....	84.7	3.5	.....	.....	.....	3,163	.....	13.7
Average.	4.2	4.1	73	31	104	1.6	91.5	3.9	56.6	32.5	56.6	3,341	1,941	17.4
1913:														
27	5.1	4.7	63	.....	.....	8.5	.....	7.0	.....	.....	.....	.....	.....	.....
81	4.4	3.9	69	.....	.....	9.8	.....	7.0	.....	.....	.....	.....	.....	.....
434	4.8	4.3	69	.....	.....	9.9	.....	7.0	.....	.....	.....	.....	.....	.....
Average.	4.7	4.3	67	.....	.....	9.4	.....	7.0	.....	.....	.....	.....	.....	.....
1914:														
81	7.9	6.3	58	31	89	20.5	98.9	5.3	.....	44.8	.....	2,900	.....	22.4
1915:														
81	11.7	7.5	65	43	108	34.0	97.2	5.5	.....	44.9	.....	4,760	.....	36.9
1916:														
81	10.1	8.2	73	42	115	19.1	61.4	3.3	.....	28.8	.....	900	.....	4.5

It seems unnecessary to consider the White durras at any length, because none of them are of commercial importance. The following observations relate exclusively to the common American form, represented by Nos. 27 and 81, which is the only type having promise. It will be noted that this form is very early in maturing. The shortest growing period was 89 days, in 1914, and the longest 115

days, in the abnormally dry season of 1916. The average duration in normal seasons is about 95 days.

Germination, and consequent plant space, has been more uniform in this durra than in any of the milo varieties. In the very dry spring of 1910, stands of one plant every 12.8 and 14.8 inches, respectively, were obtained from the two lots. In the wet spring of 1915, when the milos germinated to rather poor stands, the one selection of White durra grown had a plant space of only 11.7 inches. The most striking physiological difference between the White durra and the milos is in relation to tillering. In some cases, as No. 27 in 1910 and 1912, absolutely no suckers were produced. In 1915, the very wet year, No. 81 produced only 34 per cent of suckers in the total stalks.

In height these selections exceed milo and White milo to a small extent. The average height is about 5 or 5.5 feet and the variation was from 4 feet in 1912 to 7 feet in 1913.

In yield these White durra selections fall below milo and feterita. The average acre yields of the two in the first six years, when both were grown, are 16.9 and 17.3 bushels, respectively, as shown in Table XIII. The average acre yield of No. 81 in the 9-year period was only 18.7 bushels. In 1915, the year of bumper yields, its record was only 36.9 bushels, about 1 bushel more than it yielded in 1908 and about 30 bushels less than that of the best milo. The yields of this selection are compared with those of other milos and durras in Table XVIII.

BUFF DURRA.

Under Buff durra are grouped, for convenience, several diverse varieties. None has been found to have any economic importance in the Panhandle.

Nos. 104 and 374 are the domestic Brown durra, which is the brown-seeded counterpart of White durra. No. 101 is a similar plant from North Africa. No. 183 is the Durra Safra or Yellow durra from Egypt, more truly a milo. No. 389 is a brown-seeded Dzhugara from Turkestan. Nos. 246, 249, and 250 are from India. Nos. 371, 372, and 376 are lots obtained from shiploads of chicken feed brought in ballast from Liverpool, England, but probably originating in India.

It is evident from the data in Table XIV that the performance of these varieties was so poor as to warrant discarding the entire lot at the end of 1913. No. 246, Dagdi Jowar, from India, seemed to be the most promising of all, but its average annual acre yield in the 6-year period was only 14 bushels. Most of the varieties were both tall in stature and late in maturing.

TABLE XIV.—*Agronomic data for Buff durra grown at the Amarillo Cereal Field Station during the 6-year period from 1908 to 1913, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Erect heads.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
101	.....	.....	67	29	96	.....	.....	.....	.....	.....	.....	.....	.....	.....
104	.....	.....	76	29	105	.....	.....	.....	.....	.....	.....	.....	.....	.....
183	.....	.....	68	31	99	.....	.....	7.0	.....	.....	.....	.....	.....	.....
246	12.6	7.0	78	29	107	44.4	.....	5.0	.....	.....	.....	.....	.....	32.0
249	9.4	5.1	77	31	108	45.7	.....	6.0	.....	.....	.....	.....	.....	.....
250	10.5	5.7	82	33	115	45.7	.....	6.0	.....	.....	.....	.....	.....	35.8
Average.	10.8	5.9	74.6	30.3	105	45.2	.....	6.0	.....	.....	.....	.....	.....	33.9
1909:														
183	15.3	14.9	72	.....	.....	2.6	.....	.....	.....	.....	47.8	.....	.....	7.8
246	13.8	10.7	83	.....	.....	22.4	.....	.....	.....	.....	51.9	.....	.....	9.8
Average.	14.5	12.8	77.5	.....	.....	12.5	.....	.....	.....	.....	49.8	.....	.....	8.8
1910:														
183	50.1	41.9	78	49	127	16.4	84.5	5.7	.....	.....	.....	.....	.....	8.6
246	76.5	32.3	124	22	146	57.8	98.5	5.5	.....	.....	.....	.....	.....	5.8
250	48.0	20.3	88	36	124	57.7	88.6	5.0	.....	.....	.....	.....	.....	.....
374	37.7	17.6	66	55	121	53.3	39.0	3.5	.....	.....	.....	.....	.....	.....
389	198.0	176.0	.....	33	115	.....	.....	6.0	.....	.....	.....	.....	.....	.....
371	.....	.....	.....	.....	.....	.....	.....	2.0	.....	.....	.....	.....	.....	.....
372	.....	.....	.....	.....	.....	.....	.....	12.0	.....	.....	.....	.....	.....	.....
376	.....	.....	.....	.....	.....	.....	.....	2.0	.....	.....	.....	.....	.....	.....
Average.	82.0	57.6	89	39	126	46.3	77.6	8.2	.....	.....	.....	.....	.....	7.2
1911:														
183	18.6	18.1	72	46	118	2.7	100.0	7.5	57.3	34.5	60.2	4,310	2,460	25.7
246	9.7	6.7	93	25	118	30.9	100.0	5.8	35.4	16.0	45.1	6,875	2,435	19.0
Average.	13.6	12.4	82.5	35.5	118	16.8	100.0	6.6	46.3	25.2	52.6	5,592	2,447	22.3
1912:														
183	8.0	7.9	86	37	123	1.2	95.3	5.5	48.8	14.9	30.5	4,380	2,140	11.3
246	20.0	7.7	90	38	128	61.5	96.8	5.0	46.1	19.8	43.0	5,200	2,398	17.6
Average.	14.0	7.8	88	37.5	125.5	31.3	96.0	5.2	47.4	17.3	36.7	4,790	2,269	14.4
1913:														
183	7.2	7.1	79	.....	.....	1.0	.....	2.5	.....	.....	.....	.....	.....	.....
246	5.2	4.6	.....	.....	.....	12.0	.....	2.5	.....	.....	.....	.....	.....	.....
Average.	6.2	5.8	79	.....	.....	6.5	.....	2.5	.....	.....	.....	.....	.....	.....

MILO HYBRIDS.

The four selections considered under this head are derived from field hybrids of milo. Nos. 199 and 200 are selections made at the field station at Channing, Tex., in 1906. The first is from a supposed hybrid between Blackhull kafir and milo, while the parentage of the second is supposed to be Sumac sorgo and milo. Nos. 238 and 239 were chance hybrids of uncertain parentage found at the Amarillo Cereal Field Station in 1907. Selections were made only of forms having heads and kernels like those of milo in shape, but with the heads strictly erect. Since most field hybrids are tall, only the lowest were selected.

All four selections were grown in 1908. All were omitted in 1909 but reinstated in 1910. The number was decreased thereafter by the elimination of the least promising until only two remained in 1914, after which these also were discarded. In spite of continued selection, none of them showed any positive value either in productiveness, earliness, or dwarfness. The results obtained in the six years are shown in Table XV.

TABLE XV.—*Agronomic data for milo hybrids grown at the Amarillo Cereal Field Station during the 7-year period from 1908 to 1914, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P.ct.*	*P.ct.*	*Feet.*	*P.ct.*	*P.ct.*	*P.ct.*	*Lbs.*	*Lbs.*	*Bus.*
199	9.7	6.1	83	30	113	37.1	.....	6.0	.....	.....	.....	.....	.....	.....
200	.....	.....	78	31	109	.....	.....	6.0	.....	.....	.....	.....	.....	.....
238	.....	.....	81	28	109	.....	.....	6.0	.....	.....	.....	.....	.....	.....
239	.....	.....	78	30	108	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average.	9.7	6.1	80	29.7	109.7	37.1	.....	6.0	.....	.....	.....	.....	.....	.....
1910:														
199–24	22.8	11.3	101	26	127	50.4	61.8	4.5	.....	.....	.....	.....	.....	8.5
238	34.4	14.2	a 76	45	121	58.7	42.2	4.7	.....	.....	.....	.....	.....	.....
238	32.8	15.4	95	27	122	52.9	92.9	5.2	.....	.....	.....	.....	.....	12.3
238	41.4	18.2	a 73	46	119	56.0	87.4	5.5	.....	.....	.....	.....	.....	8.0
Average.	32.8	14.8	86.2	36	122	54.5	71.1	4.9	.....	.....	.....	.....	.....	9.6
1911:														
199–24	11.2	9.2	78	40	118	17.4	.....	4.3	44.3	22.2	50.9	5,355	2,375	20.9
238	19.5	11.8	84	34	118	39.4	.....	6.3	36.5	23.2	63.5	6,115	2,235	24.5
238	18.0	10.0	84	34	118	44.5	.....	6.5	33.3	19.4	58.3	6,152	2,052	20.7
Average.	16.2	15.2	82	36	118	33.4	.....	5.7	38.0	21.6	57.5	5,540	2,220	22.0
1912:														
199–24	10.7	7.0	90	42	132	36.1	84.9	4.5	35.6	14.9	41.8	6,780	2,415	17.4
238	8.0	5.0	90	45	135	33.9	74.5	4.0	30.6	18.3	45.1	5,920	2,413	18.8
238	11.2	5.7	90	45	135	48.9	72.2	4.5	40.4	22.3	55.1	5,420	2,192	20.8
Average.	9.9	5.9	90	44	134	39.6	77.2	4.3	35.5	18.5	47.3	6,040	2,340	19.0
1913:														
199–24	4.8	4.1	77	.....	.....	15.4	.....	2.5	.....	.....	.....	.....	.....	.....
238	5.2	3.8	72	.....	.....	28.1	.....	2.5	.....	.....	.....	.....	.....	.....
238	12.5	6.9	85	.....	.....	45.2	.....	2.5	.....	.....	.....	.....	.....	.....
Average.	7.5	4.9	78	.....	.....	29.5	.....	2.5	.....	.....	.....	.....	.....	.....
1914:														
199–24	8.7	6.3	85	25	110	28.1	40.2	3.5	12.8	7.7	.....	5,140	660	6.9
238	13.0	6.4	80	27	107	50.7	23.4	4.0	9.3	5.3	.....	4,520	420	4.1
Average.	10.9	6.5	82.5	26	108.5	39.4	31.8	3.8	11.0	6.5	.....	4,830	540	5.5

a First and only heads.

DURRA-KAFIR HYBRIDS.

Only five separate hybrids are represented in the 18 selections contained in Table XVI. The remainder are varying forms selected from No. 198. Of the five, No. 141 is a hybrid called "Davis corn" found growing locally in Oklahoma and probably a cross between

Blackhull kafir and White durra. It was discarded after the season of 1912. No. 198 was a field hybrid, supposedly between Blackhull kafir and White durra, which occurred at the Channing Field Station in 1906. Among the various forms appearing in the second generation were many that seemed very promising. They appeared to combine the desirable earliness and low stature of the durra with head and seed characters more like those of kafir. Selections of these were made, and a number of them have been continued until the present time.

TABLE XVI.—*Agronomic data for durra-kafir hybrids grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plant.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
141	11.9	6.6	85	42	127	36.9	.....	6.0	.....	.....	.....	.....	.....	.....
198–1	9.1	5.7	76	26	102	37.3	.....	4.5	.....	.....	.....	.....	.....	.....
198–3	.....	.....	76	23	99	.....	.....	4.6	.....	.....	.....	.....	.....	.....
198–7	10.3	5.4	75	25	100	47.5	.....	4.5	.....	.....	.....	.....	.....	41.0
198–8	.....	.....	67	30	97	.....	.....	.....	.....	.....	.....	.....	.....	.....
198–9	.....	.....	75	32	107	.....	.....	5.0	.....	.....	.....	.....	.....	.....
198–11	9.8	6.4	76	26	102	34.7	.....	4.5	.....	.....	.....	.....	.....	34.5
198–12	9.4	5.4	80	23	103	42.5	.....	4.5	.....	.....	.....	.....	.....	34.5
198–15	8.6	6.3	67	31	98	26.7	.....	4.5	.....	.....	.....	.....	.....	27.4
198–16	.....	.....	83	34	117	.....	.....	3.5	.....	.....	.....	.....	.....	.....
198–18	.....	.....	78	27	105	.....	.....	4.5	.....	.....	.....	.....	.....	.....
198–19	.....	.....	78	24	102	.....	.....	4.5	.....	.....	.....	.....	.....	.....
198–20	.....	.....	76	25	101	.....	.....	3.5	.....	.....	.....	.....	.....	.....
237	8.9	6.8	78	24	102	23.6	.....	5.5	.....	.....	.....	.....	.....	24.0
240	8.0	4.4	67	31	98	45.0	.....	4.0	.....	.....	.....	.....	.....	35.7
245	.....	.....	78	30	108	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average	9.5	5.8	75.9	28.3	104.2	36.7	.....	4.5	.....	.....	.....	.....	.....	32.8
1909:														
198–1–1	13.8	9.4	75	.....	.....	31.8	.....	.....	.....	.....	.....	.....	.....	1.2
198–7–3	15.5	9.2	78	.....	.....	40.6	.....	.....	.....	.....	.....	.....	.....	2.8
198–11–1	19.2	12.9	76	.....	.....	32.5	.....	.....	.....	.....	.....	.....	.....	6.7
198 – 12 – 1 and 2	14.7	9.9	73	.....	.....	32.6	.....	.....	.....	.....	.....	.....	.....	3.1
198–12–4	14.9	9.7	72	.....	.....	34.9	.....	.....	.....	.....	.....	.....	.....	3.2
198–15–3	14.1	13.3	69	.....	.....	5.6	.....	.....	.....	.....	.....	.....	.....	7.8
198–19–1 [a]	13.4	11.4	74	.....	.....	14.9	.....	.....	.....	.....	.....	.....	.....	3.5
198–19–1 [b]	16.3	11.9	71	.....	.....	26.9	.....	.....	.....	.....	.....	.....	.....	5.6
237–1	.....	.....	74	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
240	14.2	10.1	71	.....	.....	28.8	.....	.....	.....	.....	.....	.....	.....	.....
Average	15.2	10.9	73.3	.....	.....	27.9	.....	.....	.....	.....	.....	.....	.....	4.2
1910 (black glumes):														
141–1–2–5	20.3	11.1	104	37	141	45.5	46.2	4.2	.....	.....	.....	.....	.....	.....
141–4–1–6	28.8	14.5	[a] 88	37	125	40.4	45.0	4.2	.....	.....	.....	.....	.....	.....
141–4–5–6	31.7	15.2	[a] 88	23	111	51.9	51.0	4.2	.....	.....	.....	.....	.....	.....
141–4–6–10	33.4	14.0	[a] 88	33	121	57.3	51.1	4.2	.....	.....	.....	.....	.....	.....
198–1–1	42.8	13.5	78	33	111	66.2	83.0	4.0	.....	.....	.....	.....	.....	7.4
198–7–3	32.2	13.1	78	33	111	59.5	76.3	4.2	.....	.....	.....	.....	.....	9.1
198 – 11 – 1 and 2	30.5	15.1	78	33	111	50.6	78.3	3.7	.....	.....	.....	.....	.....	7.9
198 – 12 – 1 and 2	32.2	14.5	75	36	111	54.9	68.6	4.0	.....	.....	.....	.....	.....	8.1
198–12–4	25.1	11.3	78	33	111	55.1	76.3	3.2	.....	.....	.....	.....	.....	7.1
198–15–3	28.4	21.8	70	36	106	23.4	94.5	3.5	.....	.....	.....	.....	.....	5.4
198 – 19 – 1 and 2	26.2	11.5	78	33	111	56.1	74.2	4.0	.....	.....	.....	.....	.....	9.0

[a] First and only heads.

TABLE XVI.—*Agronomic data for durra-kafir hybrids grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plant.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1910 (white glumes):	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
198-7-3	17.7	6.4	94	25	119	63.7	82.4	4.5	.....	.....	.....	.....	.....	21.2
198 - 12 - 1 and 2	20.3	8.2	94	25	119	59.5	82.3	4.0	.....	.....	.....	.....	.....	16.3
198-12-4	16.3	6.5	94	25	119	59.9	85.9	4.0	.....	.....	.....	.....	.....	18.8
198-15-3	19.5	13.5	75	34	109	30.7	100.0	3.7	.....	.....	.....	.....	.....	16.0
198-19-3	21.0	8.0	91	28	119	61.7	66.4	5.0	.....	.....	.....	.....	.....	17.0
237	16.1	11.3	94	25	119	29.9	99.3	4.2	.....	.....	.....	.....	.....	12.7
240	18.5	6.7	75	34	109	63.6	88.1	3.2	.....	.....	.....	.....	.....	17.0
Average	25.6	12.0	84.4	31.3	115.7	51.6	74.9	4.0	.....	.....	.....	.....	.....	12.3
1911 (black glumes):														
141-1-2-5	3.2	3.0	77	46	123	6.5	.....	5.7	28.3	14.0	50.8	7,881	2,231	19.6
141-4-5-8	4.1	3.4	77	46	123	16.8	.....	5.7	29.2	9.9	34.1	7,775	2,275	13.4
198-1-1-2	3.2	2.5	72	33	105	21.5	.....	6.0	53.7	27.8	51.9	7,768	4,168	37.3
198-7-3	5.9	3.8	75	30	105	36.6	.....	5.7	47.5	26.2	55.1	6,674	3,174	30.2
198-11-1	5.6	4.3	77	28	105	23.9	.....	5.5	52.3	31.3	59.8	7,080	3,700	38.2
198-12-1	4.8	4.3	75	30	105	9.6	.....	5.7	55.7	32.2	57.8	6,332	3,472	34.6
198-12-4	6.1	4.1	72	33	105	32.2	.....	6.0	54.5	27.3	50.0	5,690	3,100	26.7
198-15-3	6.3	5.7	70	30	100	9.2	.....	6.5	59.5	38.3	64.2	6,039	3,599	39.9
198-19-1	5.4	4.0	72	33	105	26.3	.....	6.5	50.2	18.7	37.2	5,375	2,700	17.3
1911 (white glumes):														
198-7-3	5.4	3.4	74	33	107	37.4	.....	6.0	43.8	22.2	50.4	7,397	3,247	28.2
198-12-4	4.8	3.8	74	33	107	19.3	.....	5.7	58.3	32.5	55.6	7,355	4,295	41.2
198-15-3	5.2	5.0	72	30	102	3.9	.....	6.3	48.3	30.4	63.0	6,485	3,135	34.1
198-19-3	3.7	3.2	74	33	107	12.5	.....	7.5	56.1	31.3	40.0	6,780	3,810	26.3
237	5.3	4.3	79	46	125	17.9	.....	6.3	23.2	7.6	33.4	12,355	2,845	16.4
240	3.5	2.5	68	34	102	29.3	.....	5.7	64.2	37.7	58.7	7,088	4,555	46.1
240-6	4.2	3.9	62	36	98	5.5	.....	4.5	42.0	40.7	96.8	4,312	1,812	30.3
Average	4.8	3.8	73.1	34.6	107.7	19.2	.....	5.9	47.9	26.7	53.6	7,021	3,257	29.9
1912 (black glumes):														
141-1-2-5	6.4	5.0	89	40	129	22.1	5.6	4.0	3.0	2.6	57.7	3,713	113	1.7
141-4-5-8	6.1	4.5	93	36	129	25.3	1.4	3.7	.9	.5	56.6	3,230	30	.3
198-1-1-2	5.1	3.7	89	35	124	26.7	25.3	3.5	28.5	6.1	21.5	2,560	730	2.7
198-7-3	6.2	4.3	89	35	124	30.7	34.9	3.5	21.3	4.6	21.7	3,700	790	3.0
198-11-1	7.7	5.4	93	31	124	29.6	39.3	3.3	37.6	8.5	22.7	2,700	1,015	4.0
198-12-1	4.8	4.1	96	28	124	14.9	24.3	3.3	27.6	4.2	15.3	2,800	773	2.0
198-12-4-1	4.6	4.0	96	28	124	13.8	34.1	3.3	.....	5.2	.....	2,453	.....	2.2
198-12-4-5	7.9	5.0	93	31	124	36.6	43.7	3.5	.....	8.2	.....	2,675	.....	3.8
198-15-3	6.4	5.6	89	35	124	13.3	37.7	3.3	.....	9.4	.....	2,533	.....	4.1
198-19-1	7.9	4.8	93	31	124	39.3	40.5	3.7	.....	8.4	.....	2,660	.....	3.9
1912 (white glumes):														
198-7-3	4.7	3.9	89	35	124	17.8	47.7	3.5	.....	11.7	.....	2,960	.....	6.0
198-12-4	3.9	3.4	89	17	106	12.0	37.9	3.3	.....	8.8	.....	3,030	.....	4.6
198-15-3	9.9	7.8	78	34	112	20.6	68.0	3.5	.....	21.3	.....	3,146	.....	11.6
198-19-3	5.2	4.0	89	35	124	22.6	63.9	4.5	.....	15.3	.....	3,595	.....	9.5
237	7.2	5.5	96	28	124	23.6	38.5	3.3	.....	7.1	.....	2,655	.....	3.3
240	4.5	3.5	89	35	124	23.6	33.9	3.3	.....	11.1	.....	2,630	.....	5.0
240-6	4.1	3.8	81	30	111	7.8	74.5	2.3	.....	32.3	.....	3,003	.....	11.5
Average	6.0	4.6	90	32	122	22.3	37.7	3.4	19.8	9.7	32.6	2,944	575	4.6
1913 (black glumes):														
198-7-3	9.7	5.2	73	.....	.....	46.1	.....	2.0	.....	.....	.....	.....	.....	.....
198-11-1	10.3	6.7	82	.....	.....	35.0	.....	2.0	.....	.....	.....	.....	.....	.....
198-12-1	7.9	6.0	82	.....	.....	24.7	.....	2.0	.....	.....	.....	.....	.....	.....
198-12-4-5	10.2	6.4	80	.....	.....	38.0	.....	2.0	.....	.....	.....	.....	.....	.....
198-15-3	12.2	9.6	73	.....	.....	21.5	.....	2.0	.....	.....	.....	.....	.....	.....
1913 (white glumes):														
198-7-3	10.6	5.5	80	.....	.....	47.9	.....	2.0	.....	.....	.....	.....	.....	.....
198-12-4	6.9	5.2	80	.....	.....	25.2	.....	2.0	.....	.....	.....	.....	.....	.....
198-15-3	12.0	8.7	73	.....	.....	27.1	.....	2.0	.....	.....	.....	.....	.....	.....
240	88.2	4.9	80	.....	.....	40.0	.....	1.5	.....	.....	.....	.....	.....	.....
240-6	9.9	5.9	73	.....	.....	40.0	.....	1.5	.....	.....	.....	.....	.....	.....
Average	9.8	6.4	77	.....	.....	34.5	.....	1.9	.....	.....	.....	.....	.....	.....

TABLE XVI.—*Agronomic data for durra-kafir hybrids grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plant.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1914 (black glumes):	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Fect.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
198–7–3	10.6	6.1	66	31	97	42.2	58.7	4.0	.....	20.2	.....	4,640	.....	16.2
198–15–3	11.2	10.2	66	31	97	9.0	83.3	3.5	.....	30.9	.....	3,880	.....	20.7
Average	10.9	8.2	66	31	97	25.6	71.0	3.7	.....	25.5	.....	4,260	.....	18.4
1914 (pale glumes):														
198–7–3	10.7	6.3	66	31	97	41.3	53.6	3.5	.....	18.8	.....	4,240	.....	13.8
198–15–3	12.2	10.7	66	31	97	11.5	74.2	3.5	.....	25.0	.....	3,440	.....	14.8
240	5.9	4.7	64	29	93	20.6	37.2	3.0	.....	15.8	.....	3,160	.....	8.6
240–6	8.2	6.1	57	30	87	26.0	78.3	2.8	.....	46.6	.....	2,400	.....	19.3
Average	9.2	6.9	63.2	30.2	93.5	24.8	60.8	3.2	.....	26.5	.....	3,310	.....	11.6
1915 (black glumes):														
198–7–3	15.0	9.5	74	49	123	36.9	98.4	5.0	.....	34.9	.....	5,720	.....	34.5
198–15–3	15.4	12.4	74	49	123	19.1	95.8	5.3	.....	30.8	.....	4,600	.....	24.5
Average	15.2	10.9	74	49	123	28.0	97.1	5.2	.....	32.8	.....	5,160	.....	29.5
1915 (pale glumes):														
198–7–3	11.3	6.9	72	51	123	39.0	100.0	5.5	.....	25.7	.....	6,333	.....	28.1
198–15–3	8.9	8.4	61	47	108	5.5	100.0	5.3	.....	19.8	.....	5,240	.....	17.9
240	13.3	6.6	74	49	123	50.0	98.9	4.5	.....	33.7	.....	5,040	.....	29.3
240–6	8.3	6.6	64	54	118	20.2	100.0	4.0	.....	52.5	.....	4,000	.....	36.2
Average	10.4	7.1	68	50	118	28.7	99.7	4.8	.....	32.9	.....	5,153	.....	28.4
1916 (black glumes):														
198–7–3	13.9	8.8	83	23	106	36.9	61.8	2.8	.....	19.4	.....	2,160	.....	7.2
198–15–3	29.0	25.0	78	37	115	13.9	55.5	2.8	.....	21.9	.....	640	.....	2.4
Average	21.5	16.9	80	30	110	25.4	58.6	2.8	.....	20.7	.....	1,400	.....	4.8
1916 (pale glumes):														
198–7–3	13.1	9.7	80	65	145	25.7	23.8	2.5	.....	20.8	.....	1,600	.....	5.7
198–15–3	21.0	18.0	80	65	145	14.1	28.2	2.5	.....	17.9	.....	560	.....	1.7
240	7.8	5.2	117	28	145	32.1	55.1	3.0	.....	7.4	.....	2,720	.....	3.5
240–6	16.5	12.4	63	34	97	24.2	63.6	2.3	.....	31.3	.....	640	.....	3.5
Average	14.6	11.3	85	48	133	24.0	42.7	2.6	.....	19.3	.....	1,355	.....	3.6

Nos. 237 and 240 were field hybrids occurring at the Amarillo field station in 1907. Presumably these also were crosses between Blackhull kafir and White durra. No. 237 was discarded at the end of 1912, but two selections of No. 240 are still grown. No. 245 is supposed to be a cross between Edra (No. 244), a white durra from Arabia, and some other variety. It appeared at Channing in 1906, and the selection was finally discarded at the end of its first season in 1908.

The number of selections grown was increased from 16 in 1908 to 18 in 1910 and then decreased until only 6 have been tested in each of the last three years. These include selections from only 2 of the

5 originally under experiment. The total number of plats grown in the nine years has been 105. The results are shown in Tables XVI and XVII, and the best strains are compared with others of the milo-durra group in Table XVIII. Beginning in 1910, an attempt was made to isolate both black-glumed and white-glumed selections from some of the selections which were not homozygous for glume color.

From a study of the data in Table XVI it appears that the selections of 198, 237, and 240 are early in maturing and the selection No. 240–6 especially so. The average duration of the growing period lies between 100 and 110 days in fairly normal seasons. In 1914, when all varieties of grain sorghums matured quickly, No. 240–6 matured in 87 days, and none of the six selections required more than 97 days to mature. In 1915, when all grain sorghums were late, these selections required only 118 days on the average, or a little less time than milo.

The germination of these hybrid selections has been good, on the average. Only once in the nine years has the plant space exceeded 15 inches. In five of these years the plant space has averaged less than 10 inches and in one year less than 5 inches. In the very dry spring of 1910 the germination was poor and the average space was 25.6 inches. In 1915, however, with its very wet spring, the average spacing was only 10.4 and 15.2 inches for the two subgroups, respectively. These selections do not tiller as freely as their kafir parent, but a little more freely than the durra parent. Only once, in 1910, have half of the stalks been suckers and only three times have as many as 30 per cent been suckers. The lowest record is 19.2 per cent, in 1911. The average height has been 4 feet.

The yields of all varieties are given in Table XVI and the yields of the best strains or races in Table XVII. No fair comparison can be made by considering the average acre yield of all the selections in all the years, because these are widely varying hybrid forms instead of pure-line selections from a mass variety. It is necessary, therefore, to determine the average acre yield of each of such selections as have been grown throughout the 9-year period. There are only three of them, but there are two others that were separated from two of the original three after the experiment had run two years. There is still another, No. 240–6, which has been grown during the last six years.

As grown during 1908 and 1909, both black-glumed and white-glumed forms occurred in the selections of No. 198. In the autumn of 1909 selections were made for glume color, and in 1910 head rows of each color were sown. The yields recorded in 1908 and 1909 are from the mixed lots, and hence are identical in both sections of the table. The subsequent yields are those given by the different selections.

TABLE XVII.—*Annual and average acre yields of the best durra-kafir hybrids grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Selection and C. I. No.	Annual yields (bushels).									Average yields.			
	1908	1909	1910	1911	1912	1913	1914	1915	1916	5 years, 1909 to 1913.	6 years, 1908 to 1913.	9 years, 1908 to 1916.	
Black glumed:										*Bus.*	*Bus.*	*Bus.*	*Cwt.*
198–1–1	.....	1.2	7.4	37.3	2.7	0	.....	.....	.....	9.7	.....	.....	.....
198–7–3	41.0	2.8	9.1	30.2	3.0	0	16.2	34.5	7.2	9.0	14.4	16.0	9.3
198–11	34.5	6.7	7.9	38.2	4.0	0	.....	.....	.....	11.4	15.2	.....	.....
198–12	34.5	3.1	8.1	34.6	2.0	0	.....	.....	.....	9.6	13.7	.....	.....
198–12–4	34.5	3.2	7.1	26.7	2.2	0	.....	.....	.....	7.8	12.3	.....	.....
198–15–3	27.4	7.8	5.4	39.9	4.1	0	20.7	24.5	2.4	11.4	14.1	14.7	8.5
198–19	.....	3.5	5.6	17.3	3.9	0	.....	.....	.....	6.1	.....	.....	.....
White glumed:													
198–7–3	41.0	2.8	21.2	28.2	6.0	0	13.8	28.1	5.7	11.6	16.5	16.3	9.5
198–12–4	34.5	3.2	18.8	41.2	4.6	0	.....	.....	.....	13.6	17.1	.....	.....
198–15–3	27.4	7.8	16.0	34.1	11.6	0	14.8	17.9	1.7	13.9	16.2	14.6	8.5
198–19–3	.....	3.5	17.0	26.3	9.5	0	.....	.....	.....	11.3	.....	.....	.....
237	24.0	4.1	12.7	16.4	3.3	0	.....	.....	.....	7.3	10.1	.....	.....
240	35.7	4.2	17.0	46.1	5.0	0	8.6	29.3	3.5	14.5	18.0	16.6	9.6
240–6	35.7	4.2	17.0	30.3	11.5	0	19.3	36.2	3.5	12.6	16.5	17.5	10.2

The average yields of the two white-glumed selections, Nos. 198–7–3 and 198–15–3, during the 9-year period are 16.3 and 14.6 bushels, respectively. If the yields recorded for these two in 1908 and 1909 are taken as the yields of the two black-glumed selections in the same years, their average yields are 16.0 and 14.7 bushels, respectively. Although the annual yields of the members of these two pairs varied greatly, the 9-year average yields of the two selections bearing the same numbers but having different glume colors are seen to be practically identical. The 9-year average yield of selection No. 240 is 16.6 bushels per acre, almost exactly that of the selection No. 198–7–3, both black glumed and white glumed.

The 6-year average acre yield of selection No. 240–6 in the years 1911 to 1916, inclusive, was 16.8 bushels, while the average yield of No. 240 itself was only 15.6 bushels in the same six years. All these average yields are much lower than those of Dwarf milo, milo, White milo, or feterita, and somewhat lower than those of White durra, the average yield of which was 18.7 bushels per acre in the same period. The yields of the durra-kafir hybrids are very irregular, although their variations correspond in general with those in the yields of other groups. In 1911 the yield of the black-glumed No. 198–15–3 equaled that of the best milo, while No. 240 surpassed it by some 7 bushels. In 1914, an unfavorable year, four of the six surpassed the best milo in yield, but in 1915, a year of abundant rainfall, the best of these fell 31 bushels behind the best milo.

The relatively low average yields of these hybrids are due in part to their comparatively poor yields in 1915, when bumper yields were

obtained from most varieties. This was due to a considerable extent to their location on a part of the farm exposed to the ravages of sparrows, by which much of the seed was destroyed. In 1908, a good year, their yields compared well with those of the other varieties. On the whole, however, their performance has been disappointing.

COMPARATIVE YIELDS OF THE MILOS AND DURRAS.

Table XVIII compares the annual and average yields of the leading varieties of the milo-durra group. The data cover 5 milos, 5 Dwarf milos, 1 lot each of Alba (White) milo, feterita, and White durra, and 6 durra-kafir hybrids, a total of 19 lots. Of these, 13 have been grown during all years and 6 during only the last seven years.

Among the six subgroups, Dwarf milo is seen to lead, with average acre yields of 26 or 27 bushels. The Standard milos and Alba milo and feterita come next, with acre yields varying from 20 to 23 bushels, in round numbers. Below them rank the White durra and durra-kafir hybrids. As noted previously, the average yields of the last named probably would have been higher if they had not been seriously attacked by sparrows in 1915, the year of very high crop yields.

TABLE XVIII.—*Annual and average acre yields of the leading varieties and races in each of the subgroups of the milo-durra group of grain sorghums grown at the Amarillo Cereal Field Station in all or most of the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Variety and C. I. No.	Annual and average acre yield (bushels).										
	1908	1909	1910	1911	1912	1913	1914	1915	1916	7 years, 1910 to 1916.	9 years, 1908 to 1916.
Milo:											
77	.....	.....	19.0	28.2	32.1	0	8.3	56.2	6.6	21.5	.....
223	37.4	16.5	18.8	24.4	23.6	0	12.8	64.8	7.6	21.7	22.9
232	30.4	3.6	9.8	30.1	33.0	0	10.7	60.0	6.6	21.5	20.5
234	43.2	5.8	18.2	33.3	23.3	0	14.8	58.6	6.9	22.2	22.7
235	.....	.....	18.9	39.3	11.9	0	8.4	67.6	7.2	21.9	.....
Dwarf milo:											
149	[a] 42.6	[a] 12.4	[a] 20.8	[b] 36.8	[b] 13.3	0	30.0	74.1	7.6	26.1	26.4
236	.....	.....	18.6	38.1	11.2	0	31.0	62.7	6.9	24.1	.....
332	[b] 39.5	[c] 14.3	[b] 18.5	37.4	24.0	0	30.0	70.3	9.7	27.2	27.1
347	.....	.....	18.2	38.9	19.1	0	27.1	72.4	10.3	26.6	.....
359	.....	.....	20.0	37.3	34.6	0	16.2	68.3	8.6	26.4	.....
Alba (White) milo:											
352	.....	.....	16.9	37.5	15.8	0	11.4	59.3	4.8	20.8	.....
Feterita:											
182	40.2	9.3	14.7	31.9	24.5	0	18.5	52.1	14.5	22.3	22.8
White durra:											
81	35.7	7.7	10.0	26.4	24.3	0	22.4	36.9	4.5	17.8	18.7
Durra-kafir hybrids:											
Black glumed—											
198–7–3	41.0	2.8	9.1	30.2	3.0	0	16.2	34.5	7.2	14.3	16.0
198–5–3	27.4	7.8	5.4	39.9	4.1	0	20.7	24.5	2.4	13.9	14.7
White glumed—											
198–7–3	41.0	2.8	21.2	28.2	6.0	0	13.8	28.1	5.7	14.7	16.3
198–15–3	27.4	7.8	16.0	34.1	11.6	0	14.8	17.9	1.7	13.7	14.6
240	35.7	4.2	17.0	46.1	5.0	0	8.6	29.3	3.5	15.6	16.6
240–6	35.7	4.2	17.0	30.3	11.5	0	19.3	36.2	3.5	16.8	17.5

[a] Average of three plats. [b] Average of two plats. [c] Average of four plats.

The Kafir Group.

The kafir group already has been described and the leading varieties separated by means of a simple key. They are the largest plants and the latest in maturing of all the groups. While there is considerable difference in size and earliness between the different varieties of kafir, none of them is both as dwarf and as early as some variety in each of the other groups except, perhaps, shallu. In most of the southern Great Plains area, the kafirs were the first varieties to be extensively grown. In Texas the milos probably had the start of the kafirs, but in Oklahoma the widespread production of milo has been a more recent development, while in Kansas milo is scarcely yet a competitor of kafir. Heads of four varieties are shown in figure 8.

FIG. 8.—Heads of four varieties of kafir: *A*, White kafir; *B*, Guinea kafir (Guinea corn of the West Indies); *C*, Blackhull kafir; *D*, Red kafir .(About one-fifth natural size.)

The results obtained from the various kafirs are shown in Tables XIX to XXX, inclusive. It will be noted that, on the whole, the kafirs have made their good yields in years of normal rainfall and have yielded little in years of deficient precipitation. Since corn can not be grown at all under these conditions, it is no disparagement to the grain sorghums that some are less adapted than others. Each variety or subgroup of the kafirs is considered separately, and the results obtained are shown in separate tables.

BLACKHULL KAFIR.

The number of different lots and selections of Blackhull kafir which have been under experiment has decreased from 19 at the beginning, in 1908, to only 5 in 1916. They vary little among them-

selves, either in height, or earliness, or in producing power. A plat of Blackhull kafir is shown in figure 9.

Table XIX shows that in fairly normal seasons, such as those of 1908, 1911, and 1915, this variety requires about three months to reach the heading stage and nearly a month more to ripen, making the total duration of the growing period 115 to 120 days. The shortest period recorded is 107 days, for No. 207 in 1908, and the longest is 150 days, for three selections in 1915. Drought may shorten the vegetative period slightly by checking growth and so inducing heading. On the other hand, drought may greatly lengthen this period if it becomes so severe as to inhibit growth altogether

FIG. 9.—A plat of Blackhull kafir, C. I. No. 203, at the Amarillo Cereal Field Station, September 10, 1907.

until rains occur. This condition occurred in 1916, when the average duration of the vegetative period alone was 128 days and none of the five selections matured.

The normal height of these varieties under Panhandle conditions is about 5 feet. Drought in early summer reduces this height materially. For instance, in 1910 to 1912, inclusive, the average height was between 4 and 4.6 feet. In 1914 and 1916 the average height fell below 4 feet, while in 1913 the crop was destroyed by drought at an average height of only 2 feet, mostly without producing any heads. In 1915, when the total precipitation was much above normal and the highest yields yet recorded were obtained, the average height was only 5.1 feet. This was due, however, to a somewhat reduced rainfall in May and June, while growth was being made, and superabundant moisture thereafter while the grain was being formed.

TABLE XIX.—*Agronomic data for Blackhull kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per ct.*	*Per ct.*	*Feet.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Bus.*
71	11.5	7.2	91	24	115	37.3	.....	5.5	.....	.....	.....	.....	.....	42.2
204-2	12.0	8.7	82	30	112	27.5	.....	5.5	.....	.....	.....	.....	.....	31.4
204-5	.....	.....	82	30	112	.....	.....	5.5	.....	.....	.....	.....	.....	.....
205-5	12.8	7.8	84	28	112	39.0	.....	5.5	.....	.....	.....	.....	.....	28.6
205-8	.....	.....	84	28	112	.....	.....	5.5	.....	.....	.....	.....	.....	.....
206	13.5	8.9	84	28	112	34.0	.....	5.5	.....	.....	.....	.....	.....	27.2
207	8.0	5.9	76	31	107	26.2	.....	5.5	.....	.....	.....	.....	.....	32.6
209-9	.....	.....	90	28	118	.....	.....	6.0	.....	.....	.....	.....	.....	.....
210	14.2	8.8	90	30	120	38.0	.....	6.0	.....	.....	.....	.....	.....	34.2
333	12.2	8.0	90	27	117	34.4	.....	5.5	.....	.....	.....	.....	.....	41.7
334	.....	.....	90	27	117	.....	.....	5.5	.....	.....	.....	.....	.....	.....
335	11.8	8.5	90	28	118	27.9	.....	5.5	.....	.....	.....	.....	.....	37.0
336	12.5	8.1	92	26	118	35.2	.....	5.5	.....	.....	.....	.....	.....	27.2
337	12.3	7.6	92	24	116	38.2	.....	5.5	.....	.....	.....	.....	.....	38.3
338	12.8	8.5	91	26	117	33.6	.....	5.5	.....	.....	.....	.....	.....	30.7
339	12.1	7.7	91	26	117	36.3	.....	5.5	.....	.....	.....	.....	.....	34.6
341	11.3	7.0	91	24	115	38.0	.....	5.5	.....	.....	.....	.....	.....	33.3
31	.....	.....	91	27	118	.....	.....	5.5	.....	.....	.....	.....	.....	.....
33	.....	.....	88	24	112	.....	.....	5.5	.....	.....	.....	.....	.....	.....
Average..	12.0	7.8	87.8	27.1	115	34.2	.....	5.6	.....	.....	.....	.....	.....	33.8
1909:														
71	11.8	9.7	98	.....	.....	17.8	.....	.....	.....	.....	.....	.....	.....	3.5
71	12.1	10.4	97	.....	.....	14.0	.....	.....	.....	.....	.....	.....	.....	3.5
204-5	12.5	10.5	89	.....	.....	16.0	.....	.....	.....	.....	.....	.....	.....	10.9
205	12.0	9.9	89	.....	.....	17.5	.....	.....	.....	.....	.....	.....	.....	5.6
210	12.0	10.1	97	.....	.....	15.8	.....	.....	.....	.....	.....	.....	.....	4.3
333	12.0	10.6	96	.....	.....	11.7	.....	.....	.....	.....	.....	.....	.....	3.4
334	11.6	10.2	95	.....	.....	12.0	.....	.....	.....	.....	.....	.....	.....	4.9
335	12.9	12.1	87	.....	.....	6.2	.....	.....	.....	.....	.....	.....	.....	10.7
337	13.0	11.1	91	.....	.....	14.6	.....	.....	.....	.....	.....	.....	.....	7.7
338	14.0	12.2	92	.....	.....	12.8	.....	.....	.....	.....	.....	.....	.....	5.2
339	13.3	11.5	94	.....	.....	13.5	.....	.....	.....	.....	.....	.....	.....	3.9
341	11.9	10.1	94	.....	.....	15.1	.....	.....	.....	.....	.....	.....	.....	7.0
Average..	12.4	10.7	92.4	.....	.....	13.9	.....	.....	.....	.....	.....	.....	.....	5.9
1910:														
71	19.3	9.1	[a]91	39	130	53.0	.....	4.0	.....	.....	.....	.....	.....	1.0
185	17.6	9.3	[a]81	43	124	47.0	.....	4.0	.....	.....	.....	.....	.....	1.4
204	19.7	11.3	107	36	143	42.8	.....	4.2	13.1	7.7	58.6	4,332	567	5.5
205	20.7	10.0	[a]76	48	124	51.7	.....	4.2	10.4	5.7	54.9	4,150	433	4.0
207	21.9	11.4	[a]81	43	124	48.2	.....	4.2	12.1	7.0	57.8	3,761	456	4.4
210	22.3	11.5	[a]91	38	129	48.6	.....	4.2	.....	.....	.....	.....	.....	1.6
242	19.7	10.2	[a]90	38	128	48.3	.....	4.0	.....	.....	.....	.....	.....	2.1
330	48.0	19.6	[a]93	36	129	59.3	.....	4.0	.....	.....	.....	.....	.....	1.5
333	19.2	10.3	[a]91	39	130	46.8	.....	4.0	.....	.....	.....	.....	.....	2.6
335	22.5	12.7	[a]91	35	126	43.4	.....	4.0	.....	.....	.....	.....	.....	4.8
337	29.2	12.6	[a]91	38	129	56.8	.....	4.0	.....	.....	.....	.....	.....	3.5
338	23.2	11.1	[a]91	39	130	52.3	.....	4.0	.....	.....	.....	.....	.....	2.6
339	27.9	12.3	[a]91	39	130	56.0	.....	4.0	.....	.....	.....	.....	.....	2.5
341	21.3	9.7	[a]90	33	123	54.4	.....	4.0	.....	.....	.....	.....	.....	2.5
355	24.0	10.7	[a]90	39	129	55.4	.....	4.0	.....	.....	.....	.....	.....	4.3
Average..	23.7	11.4	89.6	38.8	128.5	50.9	.....	4.1	.....	.....	.....	.....	.....	2.9
1911:														
71	8.3	4.8	89	35	124	42.6	.....	4.5	34.0	19.8	58.1	8,839	2,739	26.5
185	8.5	4.8	96	28	124	43.2	.....	4.5	25.5	12.1	47.3	8,379	2,139	16.9
204	6.5	4.4	87	37	124	32.4	.....	5.0	29.7	14.7	49.4	7,744	2,304	19.0
205	6.0	4.1	89	35	124	31.5	.....	5.0	31.8	15.2	47.8	7,949	2,529	20.2
207	6.9	4.7	89	35	124	31.5	.....	5.0	27.5	11.7	40.3	5,800	1,695	11.4
210	8.8	4.8	96	28	124	45.5	.....	4.5	28.1	14.0	49.8	7,932	2,232	18.6
242	6.5	3.8	96	28	124	41.2	.....	4.5	21.5	7.8	36.5	8,901	1,921	11.7
330	5.6	3.5	96	28	124	37.6	.....	4.5	17.9	6.9	38.5	9,291	1,671	12.4
333	5.2	3.6	95	30	125	31.9	.....	4.5	18.3	5.9	32.3	9,612	1,765	9.5
335	9.9	7.0	86	46	132	29.0	.....	4.5	37.3	23.0	61.7	5,360	2,000	20.6
337	8.6	5.8	88	44	132	32.4	.....	4.5	35.8	22.8	63.6	5,520	1,980	21.0
338	11.8	7.8	88	44	132	34.2	.....	4.5	38.9	26.4	67.9	5,340	2,080	23.6

[a] First and only heads.

TABLE XIX.—*Agronomic data for Blackhull kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1911—Contd.	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per ct.*	*Per ct.*	*Feet.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Bus.*
339	12.1	7.1	88	44	132	41.1	.....	4.5	32.2	21.4	63.0	5,995	1,975	21.4
341	13.2	7.3	86	46	132	44.6	.....	4.5	41.2	27.6	66.9	5,179	2,139	23.9
355	11.3	7.0	88	44	132	39.1	.....	4.5	36.9	24.8	67.2	5,839	2,159	24.2
Average..	8.6	5.4	90.4	36.8	127	37.1	.....	4.6	30.4	16.9	52.7	7,125	2,088	18.7
1912:														
71	10.5	5.5	a 89	51	140	47.2	22.8	4.3	7.8	4.2	54.6	6,620	520	4.7
185	11.3	5.8	a 89	51	140	48.7	23.0	4.3	8.0	4.4	54.8	6,200	500	4.6
204	9.9	5.2	96	39	135	46.7	53.3	4.3	29.2	11.0	38.0	4,980	b 1,440	9.2
205	10.6	5.8	96	39	135	49.2	34.6	4.3	22.0	5.9	26.7	4,390	978	4.4
207	10.6	5.6	100	40	140	47.7	37.2	4.0	23.7	6.1	26.0	4,340	b 1,033	4.5
210	9.7	5.7	a 93	47	140	41.3	15.6	4.3	5.2	2.9	57.5	6,140	320	3.1
242	9.2	5.1	a 89	51	140	44.7	14.6	4.3	4.0	2.3	58.5	6,818	278	2.7
330	9.3	5.6	a 89	51	140	39.7	21.0	4.3	6.7	3.9	58.3	5,895	395	3.8
333	8.4	5.8	a 89	51	140	30.9	11.7	4.3	4.8	2.6	55.0	5,720	280	2.6
335	7.6	5.5	a 89	51	140	26.9	17.0	4.3	7.4	4.4	59.5	6,180	460	4.6
337	9.6	5.6	a 89	51	140	41.4	26.0	4.3	7.6	4.3	56.8	6,580	500	4.7
338	9.9	5.5	a 89	51	140	41.2	21.9	4.3	6.7	3.8	57.2	6,755	455	4.3
339	11.2	5.5	a 89	51	140	51.0	15.2	4.3	4.3	2.1	51.1	6,395	275	2.3
341	14.3	6.6	99	40	139	53.7	47.6	4.0	18.7	10.7	57.4	3,815	715	6.8
355	12.4	6.3	a 88	51	139	49.0	15.9	4.0	6.3	3.6	56.8	5,295	335	3.2
Average..	10.3	5.6	91.5	47.6	139.2	43.9	25.1	4.2	10.8	4.8	51.2	5,741	565	4.3
1913:														
71	7.1	4.8	.....	.....	.....	31.8	.....	2.0	.....	.....	.....	.....	.....	.....
185	8.5	5.8	.....	.....	.....	32.0	.....	2.0	.....	.....	.....	.....	.....	.....
204	6.4	4.5	85	.....	.....	29.6	.....	2.0	.....	.....	.....	.....	.....	.....
205	6.9	4.4	85	.....	.....	33.5	.....	2.0	.....	.....	.....	.....	.....	.....
207	7.5	5.0	85	.....	.....	31.5	.....	2.0	.....	.....	.....	.....	.....	.....
210	8.3	5.5	.....	.....	.....	34.3	.....	2.0	.....	.....	.....	.....	.....	.....
242	8.8	5.9	.....	.....	.....	32.9	.....	2.0	.....	.....	.....	.....	.....	.....
330	6.5	4.2	.....	.....	.....	36.2	.....	2.0	.....	.....	.....	.....	.....	.....
333	8.4	5.4	.....	.....	.....	35.4	.....	2.0	.....	.....	.....	.....	.....	.....
335	9.0	6.2	.....	.....	.....	34.5	.....	2.0	.....	.....	.....	.....	.....	.....
337	7.8	5.1	.....	.....	.....	35.2	.....	2.0	.....	.....	.....	.....	.....	.....
338	8.1	5.2	.....	.....	.....	35.8	.....	2.0	.....	.....	.....	.....	.....	.....
339	16.1	9.2	.....	.....	.....	43.9	.....	2.0	.....	.....	.....	.....	.....	.....
341	5.8	4.4	.....	.....	.....	25.0	.....	2.0	.....	.....	.....	.....	.....	.....
355	6.9	4.9	.....	.....	.....	28.8	.....	2.0	.....	.....	.....	.....	.....	.....
502	9.5	5.9	.....	.....	.....	37.9	.....	2.0	.....	.....	.....	.....	.....	.....
Average..	8.2	5.4	.....	.....	.....	33.6	.....	2.0	.....	.....	.....	.....	.....	.....
1914:														
71	10.8	8.4	82	36	118	24.2	60.4	4.0	30.6	16.5	.....	5,100	1,560	14.0
204	6.9	6.1	82	29	111	11.7	53.3	3.8	.....	12.5	.....	5,120	.....	10.7
207	9.3	6.9	82	29	111	25.6	56.5	3.8	.....	12.7	.....	4,720	.....	10.0
335	9.5	7.9	82	36	118	16.5	51.2	4.0	26.0	14.5	.....	4,680	1,220	11.3
337	12.2	8.0	82	36	118	34.4	46.7	4.0	22.5	12.6	.....	4,440	1,000	9.3
341	8.1	5.1	87	31	118	36.6	28.6	3.8	13.9	7.9	.....	4,020	560	5.3
Average..	9.4	7.1	82.8	32.8	115.6	24.8	49.4	3.9	23.2	12.8	.....	4,680	1,085	10.1
1915:														
71	10.3	6.6	91	59	150	35.7	94.3	5.3	42.2	31.2	73.0	12,320	5,200	64.0
204	10.2	8.6	87	49	136	15.7	92.4	5.0	38.6	29.6	76.7	7,760	3,000	38.3
207	15.1	8.6	87	54	141	43.1	93.5	5.0	42.1	30.0	71.3	7,120	3,000	35.7
335	10.2	6.9	91	59	150	33.0	97.0	5.0	45.3	32.6	72.3	11,460	5,200	62.7
337	10.2	5.3	94	56	150	48.3	82.0	5.3	42.0	31.2	74.4	10,280	5,160	64.0
341	17.3	8.7	87	52	139	49.6	98.9	5.3	53.5	39.4	73.7	7,100	3,800	46.7
Average..	12.2	7.4	89.5	54.8	144	37.6	93.0	5.1	43.9	32.3	73.6	9,340	4,226	51.9
1916:														
71	15.1	10.0	128	Did not mature.		34.0	34.3	3.5	No yields.					
204	11.9	7.6	128			36.2	30.2	3.5						
207	13.5	8.9	128			34.3	28.4	3.5						
355	9.1	6.4	128			30.0	24.2	3.5						
357	14.1	8.5	128			39.5	50.8	4.3						
Average..	12.7	8.3	128	.....	.....	34.8	33.6	3.7						

a First and only heads.

b Machine headed.

The stands obtained vary somewhat with the conditions at sowing time. Either a cold, wet spring or an extra dry soil may reduce germination and consequent stand. The distance between plants in the Blackhull kafir varied from about 8 inches in 1911 and 1913 to 9, 10, and 12 inches in all the other years except 1910, when dry soil reduced germination and so doubled the average plant space.

The average stalk space is governed by conditions occurring during the vegetative period and determining the formation of suckers. In general, about one-third of the total stalks are suckers, making a proportion of 2 main stalks to 1 sucker. In 1909 the spring drought reduced the percentage to about 14, while in 1910 the May rains combined with thin stand induced vegetative growth until half the stalks were suckers. Both these were years of drought which reduced the yields almost to the vanishing point. It will be noted that in the dry year, 1912, when the spring rains were sufficient to produce 44 per cent of suckers, only 25 per cent of all stalks were able to produce heads.

TABLE XX.—*Annual and average yields of standard Blackhull kafir, Sunrise kafir, Dawn (dwarf) kafir, and White kafir grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Variety and C. I. No.	Annual yields (bushels).									Average yields.				
	1908	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	6 years, 1908 to 1913.	8 years, 1909 to 1916.	9 years, 1908 to 1916.	
Standard:										*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Cwt.*
71	42.2	3.5	1.0	26.5	4.7	0	14.0	64.0	0	8.1	13.0	14.2	17.3	10.4
185	.....	.....	1.4	16.9	4.6	0	.....	.....	.....	5.7	.....	.....	.....	.....
204	31.4	10.9	5.5	19.0	9.2	0	10.7	38.3	0	8.4	12.7	11.7	13.9	8.3
205	28.6	5.6	4.0	20.2	4.4	0	.....	.....	.....	7.2	10.5	.....	.....	.....
206	27.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
207	32.6	6.3	4.4	11.4	4.5	0	10.0	35.7	0	5.1	9.9	9.0	11.7	7.0
210	34.2	4.3	1.6	18.6	3.1	0	.....	.....	.....	5.8	10.3	.....	.....	.....
242	.....	.....	2.1	11.7	2.7	0	.....	.....	.....	4.1	.....	.....	.....	.....
330	.....	.....	1.5	12.4	3.8	0	.....	.....	.....	4.4	.....	.....	.....	.....
333	41.7	4.2	2.6	9.5	2.6	0	.....	.....	.....	3.7	10.1	.....	.....	.....
335	37.0	10.7	4.8	20.6	4.6	0	11.3	62.7	0	7.5	13.0	14.3	16.9	10.1
336	27.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
337	38.3	7.7	3.5	21.0	4.7	0	9.3	64.0	0	7.3	12.5	13.8	16.5	9.9
338	30.7	5.2	2.6	23.6	4.3	0	.....	.....	.....	7.6	11.1	.....	.....	.....
339	34.6	3.9	2.5	21.4	2.3	0	.....	.....	.....	6.6	10.8	.....	.....	.....
341	33.3	7.0	2.5	23.9	6.8	0	5.3	46.7	0	8.3	12.3	11.5	13.9	.....
355	.....	.....	4.3	24.2	3.2	0	.....	.....	.....	7.9	.....	.....	.....	.....
Sunrise:														
472	.....	10.8	7.6	21.4	8.0	0	10.4	56.0	9.3	9.3	.....	15.4	.....	.....
Dawn:														
340	29.0	14.4	[a]9.3	[a]34.9	[a]9.6	0	14.7	53.3	3.7	13.5	16.2	17.5	18.8	11.3
White:														
342	.....	8.7	10.1	26.3	16.5	0	14.7	.....	.....	13.2	.....	.....	.....	.....
370	.....	.....	8.8	23.7	13.5	0	14.3	37.3	4.0	11.5	.....	.....	.....	.....

[a] Average yield from three plats.

A study of the annual and average acre yields, as given in Table XX, is very interesting in the light of the summary of climatic conditions given previously. In two years, 1913 and 1916, absolutely no yields of grain were obtained. In three years the average

yields were between 3 and 6 bushels per acre. In two years, 1911 and 1914, small yields, averaging 18.7 and 10.1 bushels, respectively, were produced. In 1908 there was a full yield, 33.8 bushels per acre, while in 1915 the very large average of 51.9 bushels was obtained. The average annual production in the entire 9-year period, based on a total of 109 plats grown, is only 12.3 bushels per acre. The highest average acre yield, in this period, is 17.3 bushels. Two other lots grown in all nine years yielded 16.9 and 16.5 bushels, respectively, while the average yield of five lots is 15.3 bushels.

The comparatively low returns given by the standard forms of Blackhull kafir led to efforts for improvement through breeding. The Early, or Sunrise, kafir, and the dwarf variety discussed next in order are two of the varieties resulting from the breeding operations. Both have yielded better in the years in which they have been grown than any of the older forms, as will be seen in Table XX and again in Table XXX, where the annual and average yields of all leading kafirs are summarized.

SUNRISE KAFIR.

The Sunrise, or Early, kafir (C. I. No. 472) was developed from a single head, which bore the selection number 30. It was selected in the autumn of 1906 by Mr. A. H. Leidigh, then superintendent of the Amarillo Cereal Field Station. The Dawn (dwarf) kafir (C. I. No. 340) has been developed from the same head, the exact origin of which is not known. Probably it was selected in one of the Blackhull kafir plats on the station at Amarillo, or at Channing, Tex., where the station was located previous to 1906, but it may have been found on some near-by farm.

Head No. 30 was used to sow a head row in 1907. The resulting plants were like ordinary Blackhull kafir in nearly all respects except earliness and stature. This row was heading on August 14, while none of the other selections headed until August 26, or 12 days later. In height, row 30 varied from 3.5 to 5 feet, while the other selections ranged from 4.5 to 5.5 or 6 feet. The heads were compact, but not completely exserted from the upper sheath. The glumes were black, and the kernels apparently were a little longer than those of ordinary kafir.

The earliness and variable stature, as also the scarcely exserted heads, indicate hybridization. Since the plants in other respects are so typically Blackhull kafir, the hybridization must have been between that variety and another having very similar characters. Among all the grain sorghums, only White kafir could impart earliness, dwarf stature, and shorter peduncles to Blackhull kafir without changing its other characters. It seems safe to conclude, therefore, that we have here the progeny of a chance hybrid between Blackhull kafir and White kafir.

Six heads were saved from this head row of selection No. 30. The seed from these heads was sown in 1908 in six head rows, numbered 30–1 to 30–6, inclusive. Later in the year Cereal Investigations No. 340 was given to the selection No. 30. Two of these six rows, Nos. 1 and 2, proved uniformly dwarf and early, and heads selected in row 1 have been the progenitors of the Dawn (dwarf) kafir hereafter considered. Rows 3 to 6 were all early, but heterozygous for height. Row 4 contained both tall and dwarf plants, but was most uniform in other respects. Heads were selected from the tall plants. Rows 3, 5, and 6 were discarded.

In 1909 five head rows were grown (C. I. No. 340–4–1 to 5). These all bred fairly true to the tall early type, though containing some dwarf stalks. Heads were selected from both tall stalks and dwarf stalks. Their records in the plats begin with this year.

In 1910, seed from heads taken from tall plants was sown in 10 head rows (C. I. No. 340–4Bt–1 to 10). The resulting plants were nearly all tall, though a few dwarfs appeared again. The average height was 5.3 feet. The tall and early selection being now fairly well fixed, it was given the distinct number C. I. No. 472, and later named Sunrise on account of its earliness. Ten head rows (C. I. No. 340–4Bd–1 to 10) also were sown with seed from the dwarf plants in No. 340–4 of 1909. The plants in these rows were all homozygous for dwarf stature and differed not at all from those grown from the seed of No. 340–1 or Dawn (dwarf) kafir.

Like all the other kafirs, this selection did not produce heads in 1913. In the other seven years the average duration of the vegetative period has been 88 days, of the fruiting period 36 days, and of the whole growing period 124 days. Blackhull kafir did not mature in 1916, and the record of Sunrise is not complete in 1909, so that comparison can be made only for the five years, 1910 to 1912, 1914, and 1915. In these five years the average duration of the three periods in Sunrise kafir was 85.6 days, 38.6 days, and 124.2 days, respectively. In Blackhull kafir the average duration of these periods in all selections was 88.8 days, 42.2 days, and 131.0 days, respectively. This shows an average shortening of the growing period by 7.5 days in favor of the Sunrise kafir, which is an item of much importance in districts where the season is fairly short and summer drought is of frequent occurrence.

The complete experimental data are found in Table XXI, a study of which shows that fairly good germination and good stands were obtained in all eight years. The closest spacing was one plant to each 4.7 inches, the widest was one plant to each 17 inches, and the average was one plant to each 9.2 inches in the 8-year period. In the very dry spring of 1910, when poor germination was recorded from nearly all varieties, the plant space in Sunrise kafir was 17 inches.

In the wet spring of 1915, however, when the average plant space in all selections of standard Blackhull kafir was 23.7 inches, the space in Sunrise kafir was only 10.2 inches per plant.

TABLE XXI.—*Agronomic data for Sunrise kafir (C. I. No. 472), grown at the Amarillo Cereal Field Station during the 8-year period from 1909 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
	Ins.	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
1909	12.3	10.6	80	.....	.....	13.8	66.6	.....	.....	.....	65.5	.....	.....	10.8
1910	17.0	6.6	90	37	127	61.4	49.4	5.3	26.5	10.1	38.6	4,485	1,178	7.6
1911	4.7	3.0	82	41	123	35.8	.....	6.3	31.1	14.6	47.1	8,716	2,716	21.4
1912	6.5	4.2	95	39	134	35.9	46.9	5.0	24.3	8.8	36.5	5,380	1,313	8.0
1913	5.7	3.6	.....	.....	.....	37.1	.....	2.0	.....	.....	.....	.....	.....	.....
1914	8.2	4.6	77	29	106	44.4	51.2	4.5	.....	11.2	.....	4,400	.....	10.4
1915	10.2	4.9	84	47	131	52.4	90.2	5.5	42.1	30.7	73.0	10,920	4,600	56.0
1916	9.1	4.4	107	21	128	51.8	65.6	5.0	.....	.....	.....	9,000	.....	9.3
Average	9.2	5.2	88	36	125	41.6	.....	4.8	.....	.....	.....	.....	.....	15.4

The average stalk space varied within much closer limits than did the plant space. The closest spacing was 3 inches, the widest was 10.6 inches, and the 8-year average was 5.2 inches. This is a very uniform spacing over a period of eight years and also a very close average spacing for a kafir variety having an average height of about 4.8 feet. In general, the tillering was proportional to the stand. The proportion of suckers varies from 13.8 to 61.4 per cent, the average being 41.6 per cent, or about one sucker to each 1.5 main stalks.

The average acre yield is 15.4 bushels in the 8-year period, as seen in Tables XX and XXI. During the same eight years the average acre yield of five selections of Blackhull kafir was 12.7 bushels, and that of the best one was 14.3 bushels. In 1913 none of the varieties produced any yields whatever, and in 1916 the standard Blackhull selections produced no grain, though Sunrise yielded at the rate of 9.3 bushels per acre. In 1909, Sunrise tied in yield with the best Blackhull kafir, and in 1910 it outyielded all Blackhull selections. In the other four years Sunrise was exceeded in yield by one or more of the standard selections, but never by the same one in all years. These comparisons can be seen to better advantage in Tables XX and XXX.

DAWN (DWARF) KAFIR.

The origin of this dwarf race (C. I. No. 340) has already been stated under Sunrise kafir, the two having developed in 1908 from selection No. 30, grown in the previous year. The chief difference

between the two is in height. The original head row of No. 30 in 1907 was heterozygous for stature, but of six head rows grown from it in 1908, two were uniformly dwarf and probably inherently so.

In 1909, 10 head rows were grown from seed of row No. 340–1 of 1908. All the rows were uniformly dwarf and early. To test the purity of this progeny in regard to dwarf stature, 10 heads were selected from the tallest of the dwarf plants and 10 from the lowest. The average difference in the height of the two sets of parents was about 6 or 8 inches. In 1910 the seed from each lot of heads was used to sow 10 head rows. There was absolutely no difference in the progeny of the two lots called, respectively, Nos. 340–1–Ad and 340–1–At.

FIG. 10.—A plat of Dawn (Dwarf) kafir, C. I. No. 340, at the Amarillo Cereal Field Station, August 17, 1915, yield, 68.3 bushels per acre.

For six generations since, or nine in all, this race has bred true for dwarf stature and earliness. A plat of Dawn kafir grown at Amarillo, Tex., in 1915, is shown in figure 10.

The number of plats grown in each year in the 9-year period has varied from 1 to 3, the total number being 17. Selection has been practiced within this race in the hope of obtaining still lower stature or earlier maturity, but without special success. The results of the experiments conducted are shown in Tables XX and XXII, and the annual and average yields of this selection are compared with those of other kafirs in Table XXX.

Besides being more dwarf than the ordinary Blackhull kafir, the Dawn kafir is also a little earlier, as will be seen in Table XXII. In 1908, when all varieties developed normally, the difference was

about eight days in favor of the Dawn, which gives it about the same earliness as Sunrise kafir. In some seasons this difference was reduced to 1 or 2 days. In 1914, a dry year, and in 1915, a wet year, the difference was increased to 13 or 14 days. In 1916, a very dry year, the Dawn headed about 10 days ahead of the standard kafir and produced some grain, but the standard produced no grain whatever.

TABLE XXII.—*Agronomic data for Dawn (dwarf) kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
340	14.1	6.8	82	25	107	51.0	.....	4.5	.....	.....	.....	.....	.....	29.0
1909:														
340	12.4	10.5	79	.....	.....	15.3	78.3	.....	.....	.....	64.9	.....	.....	14.4
1910:														
340	21.2	8.4	91	35	126	60.4	73.8	4.0	39.0	17.3	44.5	3,363	1,310	9.7
340	23.9	8.6	91	38	129	64.2	63.2	4.0	31.1	14.3	45.9	3,884	1,209	9.3
340	23.7	8.5	90	38	128	64.4	61.3	4.0	30.6	14.6	47.7	3,644	1,117	8.9
Average	22.9	8.5	90.6	37	127.6	63.0	66.1	4.0	33.6	15.4	46.0	3,630	1,212	9.3
1911:														
340	3.4	2.6	79	46	125	24.4	.....	5.0	36.3	16.7	45.8	9,320	3,390	35.9
340	9.2	4.9	77	46	123	46.8	.....	4.3	48.0	28.3	59.0	7,491	3,600	35.4
340	9.1	5.3	77	46	123	42.3	.....	4.3	43.3	20.7	62.3	7,423	3,214	33.4
Average	7.2	4.3	77.7	46	123.7	37.8	.....	4.5	42.5	21.9	55.7	8,078	3,401	34.9
1912:														
340	7.7	5.2	95	39	134	32.4	61.5	3.5	46.7	17.6	37.7	3,110	1,453	9.1
340	8.5	4.9	95	39	134	42.2	65.9	3.5	34.3	14.2	41.3	4,990	1,713	11.8
340	7.7	4.6	95	42	137	39.8	52.8	3.5	26.4	8.3	31.6	5,900	1,558	8.0
Average	7.9	4.9	95	40	135	38.1	60.0	3.5	35.8	13.3	36.9	4,666	1,574	9.6
1913:														
340	7.4	4.8	80	.....	.....	34.7	.....	1.5	.....	.....	.....	.....	.....	.....
340	8.1	5.1	80	.....	.....	36.7	.....	1.5	.....	.....	.....	.....	.....	.....
340	7.4	4.5	80	.....	.....	40.5	.....	1.5	.....	.....	.....	.....	.....	.....
Average	7.6	4.8	80	.....	.....	37.3	.....	1.5	.....	.....	.....	.....	.....	.....
1914:														
340	5.7	4.8	73	29	102	15.7	61.8	3.0	.....	16.1	.....	5,440	.....	14.7
1915:														
340	10.2	5.6	81	50	131	45.3	94.8	4.3	49.2	36.1	73.4	8,860	4,360	53.3
1916:														
340	9.1	4.4	118	26	144	50.9	45.2	3.3	.....	.....	.....	5,200	.....	3.7

In the matter of germination and stand, the Dawn kafir has been comparable to the ordinary Blackhull kafir and to the Sunrise kafir. In 1908, the plant space was 14.1 inches and in 1910, a dry spring, it was 22.9 inches. The average spacing in the entire period of nine years was 11.4 inches, which is about 1 inch closer than that of Blackhull kafir, but is about 2 inches wider than that of Sunrise kafir. The final stand, or original stalks plus suckers, has been good. The average stalk space is 6.1 inches, compared with 7.6

inches in Blackhull kafir and 5.2 inches in Sunrise kafir. The proportion of suckers to main stalks has exceeded 1 to 1 appreciably only once, in 1910, when the suckers formed 63 per cent of the total stalks. In general, it may be said that the Dawn kafir shows about the same reactions to environment as does the Blackhull kafir except in the matter of earliness and consequent yield, especially in unfavorable seasons.

The average acre yield of Dawn kafir, as shown in Tables XX and XXII, has been 18.8 bushels in the 9-year period, while that of all lots of the ordinary Blackhull kafir has been only 12.3 bushels. During this period the best lot of Blackhull has averaged 17.3 bushels and the average yield of five lots has been 15.3 bushels. During the eight years in which the Sunrise kafir also has been grown and comparison can be made, the average yield of the best selection of Blackhull kafir (C. I. No. 71) was 14.2 bushels, that of the Sunrise kafir was 15.4 bushels, and that of the Dawn kafir was 17.5 bushels per acre. It is in the dry seasons that the Dawn shows its significant advantage over Blackhull kafir. In 1908, a normal season, the Dawn was outyielded by ten selections of Blackhull kafir and by the average of all. In 1915, an abnormally favorable season, its yield was exceeded by those of three out of the six Blackhull selections grown, though not by the average of all. In every other year except 1913, when no yields were obtained from any varieties, it markedly outyielded Blackhull kafir. Not only did it exceed that variety in average yield, but also in the comparative yield of the best plat each year. In fact, the poorest plat of Dawn outyielded the best plat of standard Blackhull in every one of the dry seasons.

WHITE KAFIR.

White kafir has been grown in the United States since the beginning of the experiments with the kafirs. In recent years, however, it has been displaced by the Blackhull kafir, and now it is rarely found in field culture. It differs from the Blackhull kafir in three characters, namely, in white glumes instead of black, in smaller and shorter plants, and in the inability to push the heads completely out of the boot or upper leaf sheath. This last defect probably is only a corollary or expression of the lower vegetative vigor of the variety.

Selection to improve its habits in the matter of the exsertion of the head was begun as early as 1907. The White kafir was normally earlier than the Blackhull kafir. If a race with good heading habits could be produced, it might be a valuable crop in unfavorable seasons and at higher altitudes where the seasons are short. While some progress has been made in producing a race with a more completely exserted head, it has not proved a very high yielder. The results obtained since 1909 are shown in Tables XX and XXIII.

TABLE XXIII.—*Agronomic data for White kafir grown at the Amarillo Cereal Field Station during the 8-year period from 1909 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1909:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Per cent.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
342	13.3	9.9	80	.....	.....	25.5	48.5	.....	.....	.....	.....	.....	.....	8.7
1910:														
342	17.1	9.0	80	45	125	47.3	82.9	3.6	42.1	18.9	45.0	3,089	1,301	10.1
370	17.3	9.0	80	45	125	47.9	76.8	3.6	37.9	16.6	43.8	3,109	1,178	8.8
Average.	17.2	9.0	80	45	125	47.6	79.4	3.6	40.0	17.7	44.4	3,099	1,239	9.9
1911:														
342	8.2	5.8	77	47	124	29.1	.....	5.3	42.2	24.3	57.3	6,474	2,754	26.3
370	8.8	5.5	77	47	124	37.6	.....	5.3	44.5	25.7	57.9	5,519	2,459	23.7
Average.	8.5	5.6	77	47	124	33.3	.....	5.3	43.3	25.0	57.6	5,996	2,606	25.0
1912:														
342	9.7	6.4	74	42	116	33.6	86.0	3.3	51.0	35.2	69.0	2,800	1,430	16.5
370	9.1	6.7	74	42	116	26.7	90.2	3.3	62.1	32.3	52.0	2,500	1,553	13.5
Average.	9.4	6.5	74	42	116	30.1	88.1	3.3	56.5	33.7	60.5	2,650	1,492	15.0
1913:														
342	11.8	7.8	65	31	96	34.3	.....	2.5	.....	.....	.....	.....	.....	.....
70	10.5	7.2	65	31	96	30.7	.....	2.5	.....	.....	.....	.....	.....	.....
Average.	11.1	7.5	65	31	96	32.5	.....	2.5	.....	.....	.....	.....	.....	.....
1914:														
342	8.1	7.2	68	23	91	12.0	74.4	3.8	.....	24.7	.....	3,560	.....	14.7
370	8.0	7.2	68	23	91	10.0	74.4	3.8	.....	24.1	.....	3,560	.....	14.3
Average.	8.0	7.2	68	23	91	11.0	74.4	3.8	.....	24.4	.....	3,560	.....	14.5
1915:														
370	10.2	6.9	77	49	126	31.7	97.8	4.8	42.5	35.0	82.4	6,400	2,720	37.3
1916:														
370	14.3	9.2	118	37	155	35.8	48.8	3.0	.....	.....	.....	3,360	.....	4.0

The White kafir has much inherent earliness, as is shown by its record in 1913 and 1914, dry years, when the duration of the total growing period was 96 and 91 days, respectively. The much longer duration in all the other years, except 1916, was caused either by slow ripening or the delayed maturing of heads which did not completely emerge from the boot. In general, it is about 10 days earlier than Sunrise kafir and 13 to 15 days earlier than Dawn kafir.

The stands obtained have corresponded rather closely to those of the Dawn kafir. They are better, therefore, than those of the Blackhull kafir, but not as good as those of the Sunrise kafir. The final stand, or stalk space, has been very uniform, but never exceedingly close. It has varied between 5.6 and 9.9 inches per stalk. The proportion of suckers has varied from 11 per cent in 1914 to 47.6 per cent in 1910. Only in that year, however, has the proportion appreciably exceeded one sucker to every two main stalks. The height has

varied from about 3 feet to more than 5 feet, the average being about 4 feet.

The average acre yield of White kafir in all eight years is about 15 bushels. This is but little better than that of the average of all selections of Blackhull kafir and much less than that of the Dawn kafir. The comparative yields of all leading kafir varieties will be found in Table XXX. White kafir has exceeded Dawn kafir only once, in 1912, while it fell far below that variety in 1915, the year of bumper crops, when its yield was only 37.3 bushels per acre. Although early in maturing and of dwarf stature and, therefore, presumably at an advantage in the many dry seasons in the past eight years, its performance has been disappointing.

RED KAFIR.

Red kafir differs from the Blackhull subgroup, including the Blackhull, Sunrise, and Dawn varieties, by its much longer and more slender spike and its red-brown seeds. It is one of the two original varieties exhibited by the Orange Free State at Philadelphia in 1876; it was bred in Georgia for many years and finally distributed in the dry-land sections of the southern Great Plains States. In the higher parts of the Panhandle of Texas it has not been as popular as the Blackhull variety, nor has it proved any better as a producer. Careful and long-continued selection so far has failed to improve it sufficiently in this respect.

The number of different selections and races in the plats has varied from seven or eight in the first six years to only two in each of the last three years of the 9-year period from 1908 to 1916, inclusive. The total has been 51 plats in the nine years. The results obtained are presented in Tables XXIV and XXV. The annual and average yields of the best races are compared with those of the other kafirs in Table XXX.

Red kafir is about six or seven days later at Amarillo, on the average, than Blackhull kafir, though in 1915, the very wet year, the Red kafir ripened a week earlier than the Blackhull. Usually the difference in time is distributed proportionately in both the vegetative and fruiting periods. In 1911, however, the vegetative period of Red kafir was three days shorter than that of Blackhull kafir, though the ripening period was eight days longer. In 1910, 1912, and 1914, on the other hand, the ripening period was two to three days shorter, while the vegetative period was two to eight days longer. In 1915 the vegetative periods of the two were of almost identical duration, but the Red kafir ripened in 47 days after heading, while the Blackhull required 54.8 days, or eight days more. The Blackhull had a little wider spacing of plants than the Red kafir, but this was equalized by the production of more suckers, so that the stalk space

was the same. The difference in these factors does not seem sufficient to explain the difference in ripening. It is said that under humid conditions the Red kafir is naturally earlier than the Blackhull. The season of 1915 approximated a humid condition in the Texas Panhandle and the early ripening in that year may have been the natural response of this variety to those conditions.

TABLE XXIV.—*Agronomic data for Red kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per ct.*	*Per ct.*	*Feet.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Bush.*
34	8.0	6.5	83	31	114	18.7	.....	5.5	.....	.....	.....	.....	.....	42.7
34-1	12.0	7.0	91	30	121	41.7	.....	5.5	.....	.....	.....	.....	.....	30.1
34-2	.....	.....	91	32	123	.....	.....	5.5	.....	.....	.....	.....	.....	.....
68	12.4	7.1	90	28	118	42.7	.....	5.5	.....	.....	.....	.....	.....	37.0
69	12.1	7.1	91	34	125	41.3	.....	5.5	.....	.....	.....	.....	.....	27.7
212	12.2	7.0	91	33	124	42.6	.....	5.5	.....	.....	.....	.....	.....	28.7
215	12.1	7.2	91	33	124	40.5	.....	5.5	.....	.....	.....	.....	.....	32.0
Average	11.5	6.9	89.7	31.5	121.3	37.9	.....	5.5	.....	.....	.....	.....	.....	33.0
1909:														
34-3	7.6	5.4	94	.....	.....	28.9	8.4	.....	.....	.....	.....	.....	.....	2.0
34-4	6.4	4.2	94	.....	.....	34.3	4.4	.....	.....	.....	.....	.....	.....	2.0
34-5	6.7	4.5	94	.....	.....	31.3	14.5	.....	.....	.....	.....	.....	.....	2.0
34	14.7	12.0	93	.....	.....	18.3	52.1	.....	.....	.....	.....	.....	.....	10.0
68	16.1	12.5	91	.....	.....	22.3	58.0	.....	.....	.....	.....	.....	.....	10.7
69	14.1	10.1	94	.....	.....	28.3	29.1	.....	.....	.....	.....	.....	.....	3.0
212	13.1	10.2	94	.....	.....	22.1	29.9	.....	.....	.....	.....	.....	.....	4.6
215	14.0	10.7	93	.....	.....	23.5	27.9	.....	.....	.....	.....	.....	.....	5.0
Average	11.6	8.7	93.4	.....	.....	26.1	28.0	.....	.....	.....	.....	.....	.....	4.9
1910:														
34	46.5	17.6	103	40	143	65.7	48.2	4.5	16.8	9.6	58.0	3,216	531	5.2
68	57.0	19.5	103	40	143	65.6	45.7	4.2	12.5	7.6	60.8	3,326	416	4.2
69	40.5	16.8	[a] 90	38	128	58.5	25.8	4.2	7.5	4.1	53.8	3,526	266	2.4
212	45.7	16.3	103	40	143	64.3	43.6	4.2	12.4	7.3	58.7	3,653	454	4.4
215	53.0	16.5	[a] 90	33	123	68.8	30.0	4.2	8.7	5.0	57.7	3,438	300	2.9
356	27.3	9.1	106	37	143	65.5	42.5	4.2	.....	.....	.....	.....	.....	7.5
366	24.4	13.0	[a] 90	28	118	46.8	38.5	4.5	.....	.....	.....	.....	.....	10.7
Average	42.1	15.5	97.8	36.6	134.4	62.2	39.2	4.2	8.2	6.7	57.8	3,432	393	5.3
1911:														
34	16.7	10.9	86	46	132	34.8	.....	4.5	39.1	25.7	65.7	4,340	1,700	18.7
68	15.4	10.0	86	46	132	35.1	.....	4.5	35.5	23.4	65.5	4,062	1,442	15.8
69	12.5	8.0	88	44	132	36.2	.....	4.5	33.9	21.2	62.7	4,935	1,675	17.5
212	11.9	7.6	88	44	132	36.1	.....	4.5	36.8	23.6	64.2	4,811	1,771	19.0
215	9.7	6.8	88	44	132	30.5	.....	4.5	35.3	21.0	59.0	4,456	1,576	15.6
356	11.3	7.8	86	46	132	31.5	.....	4.7	42.3	27.3	64.5	5,340	2,260	24.3
366	16.3	10.4	86	46	132	36.5	.....	4.7	[b]60.3	32.5	64.6	3,078	1,859	20.0
Average	13.4	8.8	86.8	45	132	34.4	.....	4.5	40.5	24.9	63.7	4,431	1,754	18.7
1912:														
34	16.8	7.4	[a] 88	51	139	56.2	19.8	4.2	6.2	3.6	57.2	4,973	313	3.0
68	16.8	6.7	[a] 88	51	139	60.1	24.7	4.5	6.8	4.0	58.3	5,735	395	3.8
69	20.0	8.2	[a] 90	49	139	58.8	30.4	4.5	7.0	4.3	61.4	5,355	375	3.8
212	15.9	6.7	[a] 92	47	139	57.9	15.0	4.5	4.4	2.4	55.5	5,235	235	2.2
215	17.1	7.1	[a] 92	47	139	58.5	20.8	4.2	5.3	3.4	64.5	5,513	293	3.1
356	16.2	7.1	99	35	134	56.4	50.8	4.5	33.8	14.7	44.8	4,540	1,495	11.2
366	16.8	7.4	104	34	138	56.0	49.1	4.5	10.9	6.0	55.2	5,775	635	5.8
445	48.0	12.6	95	44	139	73.6	28.8	4.2	5.5	1.6	30.2	4,025	225	1.1
Average	21.2	7.9	93.5	44.5	138	59.7	29.9	4.3	9.9	5.0	53.4	5,143	496	4.3

[a] First and only heads. [b] Machine headed.

TABLE XXIV.—*Agronomic data for Red kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1913:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Perct.*	*Perct.*	*Feet.*	*Perct.*	*Perct.*	*Perct.*	*Lbs.*	*Lbs.*	*Bus.*
34	10.3	6.4	.....	.....	.....	37.5	.....	2.0	.....	.....	.....	.....	.....	.....
68	12.3	7.2	.....	.....	.....	41.3	.....	2.0	.....	.....	.....	.....	.....	.....
69	10.2	6.3	.....	.....	.....	38.2	.....	2.0	.....	.....	.....	.....	.....	.....
212	10.9	6.5	.....	.....	.....	40.5	.....	2.0	.....	.....	.....	.....	.....	.....
215	9.2	5.8	.....	.....	.....	37.0	.....	2.0	.....	.....	.....	.....	.....	.....
356	8.8	5.8	.....	.....	.....	31.0	.....	2.0	.....	.....	.....	.....	.....	.....
366	8.7	5.9	.....	.....	.....	32.3	.....	2.0	.....	.....	.....	.....	.....	.....
445	15.5	5.9	.....	.....	.....	61.7	.....	2.0	.....	.....	.....	.....	.....	.....
Average	10.7	6.2	.....	.....	.....	39.9	.....	2.0	.....	.....	.....	.....	.....	.....
1914:														
34	9.1	6.9	87	31	118	24.0	65.2	4.0	28.1	18.3	.....	4,350	.....	13.3
356	5.7	4.9	87	31	118	13.1	56.2	4.0	24.8	16.8	.....	4,500	.....	15.8
Average	7.4	4.9	87	31	118	18.5	60.7	4.0	26.4	17.5	.....	4,425	.....	14.6
1915:														
34	10.7	7.9	91	48	139	26.3	96.9	5.5	46.1	35.6	77.3	7,660	3,440	44.3
356	11.5	7.3	89	46	135	36.7	95.2	5.8	.....	.....	.....	.....	.....	57.0
Average	11.1	7.6	90	47	137	31.5	96.1	5.6	.....	.....	.....	.....	.....	50.6
1916:														
34	12.5	7.9	127	.....	.....	36.4	43.2	3.8	.....	.....	.....	4,200	.....	.....
356	15.4	10.0	127	.....	.....	35.0	54.0	3.8	.....	.....	.....	3,720	.....	.....
Average	13.9	9.0	127	.....	.....	35.7	48.6	3.8	.....	.....	.....	3,960	.....	.....

The stand obtained from Red kafir has been uniformly poorer than that obtained from Blackhull kafir. On the average, it has been about 35 per cent poorer. The best stand obtained was in 1914, when each plant had only 7.4 inches of space. The poorest was in the very dry spring of 1910, when each plant had 42.1 inches of space. The average has been about 16.5 inches, or about 4 inches more than the average for Blackhull kafir. The difference in stalk space has not been very great, however, owing to the abundant tillering in Red kafir. In 1911 Red kafir was outtillered by the Blackhull kafir, although the Blackhull already had the much thicker stand. In 1914 Blackhull again tillered more than the Red kafir, but in this year it had a thinner stand than the Red. In 1915, when the stand of Blackhull was about 9 per cent thinner than that of Red, its tillering was 6 per cent more. In 1910 and again in 1912, 60 per cent or more of the Red kafir stalks produced were suckers.

The average height of the Red kafir has been about 4.5 feet, which is about the same as that of Blackhull kafir.

The yields obtained in the experiments with Red kafir are shown in Tables XXIV and XXV, and those of the leading selections are compared with the yields of other kafir varieties in Table XXX. A study of the data shows that the best Red kafir has made a 9-year

average acre yield of 13.9 bushels, while the best selection of the Blackhull varieties has made an average acre yield of 17.3 bushels in the same period. In two years, 1910 and 1914, the average acre yields of all Red kafir selections have exceeded those of all Blackhull selections. In two other years they have equaled those of the Blackhull selections; in three years they have been lower, and in two years both varieties have failed completely. When only the yield of the best plat in each year is considered, the Red kafir has outranked the Blackhull four times, has been outranked by Blackhull three times, and twice both have failed to produce any grain. The same selection has not been the high-yielding plat in either variety more than two or three times. The annual and average acre yields from each selection, during such part of the 9-year period as they were under experiment, are shown in Table XXV, while the same data from all the Blackhull varieties are shown in Table XX. The highest yield produced by the two varieties was in 1915, when Blackhull yielded 64 bushels and Red kafir 57 bushels per acre. The yields of the leading races of all kafir varieties are compared in Table XXX.

TABLE XXV.—*Annual and average yields of Red kafir grown at the Amarillo Cereal Field Station in periods of varying length during the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

C. I. No.	Annual yields (bushels).									Average yields.				
	1908	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	6 years, 1908 to 1913.	7 years, 1910 to 1916.	9 years, 1908 to 1916.	
										Bus.	*Bus.*	*Bus.*	*Bus.*	*Cwt.*
34	[a]36.4	[b]4.0	5.2	18.7	3.0	0	13.3	44.3	0	6.7	11.2	12.1	13.9	8.3
68	37.0	10.7	4.2	15.8	3.8	0	.....	.....	.....	6.0	11.9	.....	.....	.....
69	27.7	3.0	2.4	17.5	3.8	0	.....	.....	.....	5.9	9.1	.....	.....	.....
212	28.7	4.6	4.4	19.0	2.2	0	.....	.....	.....	6.4	9.8	.....	.....	.....
215	32.0	5.0	2.9	15.6	3.1	0	.....	.....	.....	5.4	9.8	.....	.....	.....
356	.....	.....	7.5	24.3	11.2	0	15.8	57.0	0	10.8	.....	9.2	.....	.....
366	.....	.....	10.7	20.0	5.8	0	.....	.....	.....	9.1	.....	.....	.....	.....
445	.....	.....	.....	.....	1.1	0	.....	.....	.....	.....	.....	.....	.....	.....

[a] Average yield from 2 plats. [b] Average yield from 4 plats.

NEW KAFIRS.

Of the varieties and selections grouped under this title, all except one are introductions from South Africa. A list of them will be found in Table XXVI, showing the accession number of the Office of Foreign Seed and Plant Introduction, the date of introduction, the source, and native name, if any. All of them belong to the kafir group, though none of them would be considered identical with varieties now grown in this country. The results obtained in the experiments are shown in Table XXVII. The plat experiments were begun in 1908 with 9 varieties. The number was increased to 12 in 1910 and 1911 and to 14 during each of the next two years. In each of the last three years only 7 varieties have been grown.

TABLE XXVI.—*Data relating to the introduction of 13 new kafirs grown at the Amarillo Cereal Field Station in part or all of the nine years from 1908 to 1916, inclusive.*

Native or other name.	C. I. No.	S. P. I. No.	Date of introduction.	Source.
Blackhull	280	21834	1908	Maiduguri, Bornu, Sudan, Africa.
Unnamed	291	21940	1908	Pretoria, Transvaal, South Africa.
Do	303	22653	1908	Grahamstown, Cape Colony, South Africa.
Boer kafir	312	19695	1907	Orange River Colony, South Africa.
Unomputshana	314	19739	1907	Cedra, Natal, South Africa.
Bhampi	316	19744	1907	Do.
Umchloenkuku	319	19762	1907	Do.
Bhampi	322	19745	1907	Do.
Jara	323	19749	1907	Do.
Phikhulo	251	19924	1907	Pretoria, Transvaal, South Africa.
Mothlokathlong	252	19925	1907	Do.
Mogathla	253	19926	1907	Do.
Unnamed	321	19737	1907	Cedra, Natal, South Africa.
Hybrid (White kafir)	432	.....	1911	Hays Branch Experiment Station, Hays, Kans.

Numerous selections have been made to improve these varieties in height and earliness and in the character of the head, and some progress has been made. Some of the best ones may stand comparison with the selections of standard Blackhull kafir, but none is yet fitted to replace any of the commercial varieties of the United States. Complete data on these varieties are given in Table XXVII, a study of which shows these kafirs to be very diverse in height and earliness. It is impossible, therefore, to consider them together, as for these and other reasons they do not comprise one variety but many. It is desirable, however, to pick out some of the best of them and to compare them as individual varieties. The annual and average yields are given in Table XXVIII.

No. 314, from Natal, is one of the best. It is fairly early, the average duration of the vegetative, fruiting, and entire growing periods being 94, 37, and 131 days, respectively. The shortest growing period was 118 days, in 1914, and the longest was 138 days. In general, the stands have been fair to good, not as good as those of Blackhull kafir, but rather similar to those of Red kafir. Following the very thin stand in 1910, the tillering was enormous, the final result being two suckers to each main stalk. In no other year, however, has the proportion been larger than about one sucker to two main stalks.

The average acre yield of No. 314 is 13.1 bushels in the 8-year period. Two complete failures are recorded, in 1913 and 1916. The yield in 1915 was 46.7 bushels per acre. Had this variety been grown in plats in 1908, the most nearly normal in the whole nine years, its average yield probably would have been about 15 bushels per acre in the nine years.

No. 316, from Natal, is also worthy of consideration. Its growing period is about the same as that of No. 314, the duration of the three

periods being 89, 43, and 132 days, respectively. The shortest was 118 days and the longest was 147 days. The stands have been slightly poorer than those of No. 314 on the average. The tillering has been more abundant, however, since in three years the proportion of suckers has exceeded one sucker to each main stalk. The average acre yield in the 8-year period has been 16 bushels, or about 3 bushels better than that of No. 314. Its yield in 1915 was 66 bushels, one of the best made by any kafir variety.

TABLE XXVII.—*Agronomic data for new kafirs grown at the Amarillo Cereal Field Station during the 8-year period from 1909 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1909:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Per cent.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
280	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.3
291	.....	.....	82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
303	.....	.....	81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
312	.....	.....	88	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.3
314	.....	.....	88	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.6
316	.....	.....	83	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.3
319	.....	.....	87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.3
322	.....	.....	81	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
323	.....	.....	88	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average	.....	.....	84.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.4
1910:														
291	29.6	9.0	a 90	33	123	69.5	18.2	5.5	.....	.....	.....	.....	.....	2.2
303	35.7	12.8	a 90	39	129	64.1	24.3	4.0	.....	.....	.....	.....	.....	.....
323	32.7	10.7	103	35	138	67.3	.....	4.0	.....	.....	.....	.....	.....	.....
251	72.0	18.4	97	36	133	74.4	70.9	5.7	.....	.....	.....	.....	.....	.....
316	34.9	10.4	a 90	41	131	70.3	24.0	4.2	.....	.....	.....	.....	.....	.....
322	29.6	10.4	a 90	38	128	64.8	.....	4.0	.....	.....	.....	.....	.....	4.1
319	46.6	15.7	103	35	138	66.4	60.3	6.2	.....	.....	.....	.....	.....	7.4
252	39.6	12.0	a 90	38	128	69.7	.....	7.0	.....	.....	.....	.....	.....	.....
253	33.3	9.8	a 100	38	138	70.5	.....	7.5	.....	.....	.....	.....	.....	.....
312	37.2	13.1	a 90	28	118	64.8	.....	5.5	.....	.....	.....	.....	.....	1.8
314	42.7	14.5	106	32	138	66.0	62.0	5.5	.....	.....	.....	.....	.....	5.7
321	16.0	6.7	a 88	37	125	57.7	.....	5.2	.....	.....	.....	.....	.....	5.3
Average	37.6	11.9	94.7	35.8	130.5	67.1	43.2	5.3	.....	.....	.....	.....	.....	4.4
1911:														
251	19.1	7.1	74	58	132	63.0	.....	6.5	30.4	14.9	49.3	5,397	1,631	13.4
291	10.8	5.8	95	38	133	46.1	.....	5.5	47.2	25.1	53.7	5,159	2,419	21.7
323	19.0	9.5	95	38	133	49.6	.....	4.3	39.8	22.5	56.5	5,624	2,098	18.1
303	13.3	7.1	88	44	132	41.9	.....	4.3	46.2	30.0	64.9	5,754	2,754	29.8
316	16.0	6.7	88	45	133	58.1	.....	4.3	48.6	31.6	65.0	5,925	2,885	40.0
319	13.5	7.3	85	47	132	46.0	.....	6.5	41.3	27.6	67.0	5,045	2,085	23.3
322	13.9	6.8	88	45	133	51.2	.....	4.5	44.5	27.8	62.6	5,626	2,506	26.1
252	12.0	6.5	88	45	133	46.0	.....	7.0	37.1	20.7	55.7	7,771	2,887	28.6
253	13.4	6.3	91	42	133	52.7	.....	6.8	38.9	18.3	53.1	6,771	2,337	20.7
312	16.5	7.9	91	42	133	52.0	.....	6.7	38.1	22.0	59.3	6,627	2,527	25.0
314	11.9	7.8	85	47	132	34.4	.....	5.8	46.7	27.2	58.2	5,561	2,601	25.2
321	26.2	12.8	88	45	133	51.1	.....	4.8	48.9	32.3	66.0	4,272	2,092	23.0
Average	17.1	7.6	88	44.6	132.6	49.3	.....	5.5	42.3	25.0	59.2	5,764	2,401	24.6

a First and only heads.

TABLE XXVII.—*Agronomic data for new kafirs grown at the Amarillo Cereal Field Station during the 8-year period from 1909 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1912:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*Per cent.*	*Per cent.*	*Feet.*	*Per cent.*	*Per cent.*	*Per cent.*	*Lbs.*	*Lbs.*	*Bus.*
251	15.2	4.8	99	30	129	68.2	39.1	5.0	23.2	7.7	33.3	4,860	1,130	6.3
291	10.1	5.1	74	39	138	49.9	29.1	4.8	18.9	6.7	35.7	5,440	1,033	6.1
323	11.7	5.1	*a* 85	54	139	56.7	23.1	4.5	10.1	5.7	56.4	5,095	515	4.8
323	12.4	5.1	*a* 85	54	139	59.2	22.4	4.5	7.8	4.5	57.7	5,640	440	4.2
303	8.4	5.1	*a* 88	52	140	39.0	11.7	4.8	6.4	3.8	59.9	5,578	358	3.5
316	11.2	5.5	*a* 92	55	147	51.1	13.4	4.5	7.7	4.7	61.7	5,938	458	4.7
319	8.8	5.0	*a* 88	59	147	42.9	18.9	6.5	8.1	4.8	59.4	5,575	455	4.5
322	11.9	5.7	*a* 88	59	147	52.3	18.8	4.5	9.0	5.4	60.3	6,820	620	6.2
432	6.2	4.2	95	33	128	29.9	54.9	4.5	18.6	11.0	58.8	6,763	1,263	12.4
252	8.7	5.3	*a* 92	55	147	39.6	10.1	6.8	4.5	2.9	64.3	6,915	315	3.3
253	8.9	4.9	*a* 92	55	147	44.3	12.1	7.0	4.3	2.6	59.8	7,695	335	3.3
312	10.5	5.3	*a* 92	56	148	49.1	11.4	6.8	4.3	2.6	61.1	6,653	293	3.0
314	7.6	6.5	105	31	136	14.6	63.5	5.0	32.7	14.6	44.5	4,860	1,593	11.8
321	8.7	4.9	88	48	136	43.5	20.6	4.5	8.7	5.0	56.8	5,373	473	4.5
Average.	10.0	5.2	92	48.5	140.5	45.7	24.9	5.2	11.7	5.8	54.9	5,943	662	5.6
1913:														
251	11.0	4.8	85			56.3		2.0						
291	6.8	4.3				39.5		2.0						
323	7.5	4.8				35.5		2.0						
323	6.9	4.1				40.9		1.5						
303	8.5	4.9				42.7		2.0						
316	8.2	5.0				38.6		2.0						
319	9.7	5.8				40.5		2.0						
322	9.5	5.3				44.2		2.0						
432	8.3	5.4				34.8		2.0						
252	11.4	6.3				44.5		2.0						
253	8.4	5.2				38.8		2.0						
312	10.6	6.0				43.4		2.0						
314	7.3	4.9				32.3		2.0						
321	7.5	4.9				35.0		2.0						
Average.	8.6	5.1				40.5		1.9						
1914:														
291	4.6	4.0	87	25	112	13.1	29.6	5.0	17.9	10.9		4,580	820	8.3
303	6.7	4.6	87	31	118	31.0	31.0	3.5	16.9	10.8		4,260	720	7.7
316	9.8	6.1	87	31	118	37.5	41.6	3.5	27.8	18.2		4,160	1,160	12.7
432	5.0	4.4	87	25	112	12.0	38.0	4.0	20.6	13.8		4,060	840	9.3
252	11.1	6.2	87	31	118	44.7	22.0	5.5	11.3	7.6		4,940	560	6.3
314	5.8	5.1	87	31	118	12.6	36.0	4.3	14.7	8.2		4,340	640	6.0
321	7.3	5.3	87	31	118	27.3	30.1	3.8	17.5	10.6		3,760	660	6.7
Average.	7.2	5.1	87	29.2	116.2	25.5	32.7	4.2	18.1	11.4		4,300	771	8.1
1915:														
291	10.1	6.8	91	41	132	32.6	96.6	6.3						44.7
303	10.2	7.0	89	42	131	31.2	92.5	4.3						51.0
316	10.2	6.6	91	40	131	35.1	97.0	4.8						66.0
432	10.2	6.0	84	52	136	40.9	92.5	4.8						59.7
252	11.6	6.6	94	45	139	44.1	96.5	7.3						50.7
314	11.3	8.6	87	45	132	23.5	98.2	5.3						46.7
321	10.2	6.1	89	43	132	40.1	99.8	5.5						54.7
Average.	10.6	6.8	89	44	133	35.4	96.1	5.5						53.3
1916:														
291	8.4	5.9	127			29.5	39.6	4.3				3,625		
303	12.6	10.4	130			18.1	24.2	3.3				1,800		
316	21.2	14.6	126			31.2	58.6	3.5				2,400		
432	14.0	8.4	128	17	145	39.6	29.2	3.3				2,160		2.0
252	13.4	9.6	125			27.8	59.5	5.0				1,800		
314	17.7	12.8	127			27.9	59.9	4.5				2,440		
321	11.2	7.0	130			38.0	27.4	3.3				3,160		
Average.	14.1	9.8	127			30.3	42.6	3.9				2,463		

a First and only heads.

Some of the other promising varieties are Nos. 303, grown during eight years, No. 321, grown in seven years, and No. 432, grown during five years. Comparative results will be found in Table XXVIII. The 8-year average acre yield of No. 303 is 11.5 bushels. The 7-year average acre yields of Nos. 303 and 321 are 13.1 and 13.5 bushels, respectively. The 5-year average acre yields of the three numbers are 12.4, 12.8, and 16.7 bushels, respectively.

TABLE XXVIII.—*Annual and average yields of all lots of new kafirs grown at the Amarillo Cereal Field Station during periods of varying length in the eight years from 1909 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

C. I. No.	Annual yields (bushels)								Average yields.				
	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	5 years— 1909 to 1913.	5 years— 1912 to 1916.	8 years, 1909 to 1916.	
									Bus.	*Bus.*	*Bus.*	*Bus.*	*Cwt.*
251	.....	.....	13.4	6.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
291	.....	2.2	21.7	6.1	.....	8.3	44.7	.....	7.5	.....	11.8	.....	.....
323	.....	.....	18.1	4.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
303	.....	.....	29.8	3.5	.....	7.7	51.0	.....	.....	.....	11.2	.....	.....
316	4.3	.....	40.0	4.7	.....	12.7	66.0	.....	11.2	9.8	16.7	16.0	9.6
319	5.3	7.4	23.3	4.5	.....	.....	.....	.....	8.8	8.1	.....	.....	.....
322	.....	4.1	26.1	6.2	.....	.....	.....	.....	9.1	.....	.....	.....	.....
432	.....	.....	.....	12.4	.....	9.3	59.7	2.0	.....	.....	16.7	.....	.....
252	.....	.....	28.6	3.3	.....	6.3	50.7	.....	.....	.....	12.1	.....	.....
253	.....	.....	20.7	3.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
312	3.3	1.8	25.0	3.0	.....	.....	.....	.....	7.5	6.6	.....	.....	.....
314	9.6	5.7	25.2	11.8	.....	6.0	46.7	.....	10.7	10.4	12.9	13.1	7.9
321	.....	5.3	23.0	4.5	.....	6.7	54.7	.....	8.2	.....	13.2	.....	.....
280	4.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

GUINEA KAFIR.

The variety here called Guinea kafir is an old variety in this country which is not now grown commercially, so far as known. It was widely advertised and tested 50 years or so ago under various names. Among them were such as "Rural Branching Sorghum," "White Millo Maize," etc. It was then grown to some extent in the Southern States, being too late to mature anywhere else. Although carefully tested both in the nursery and in field plats at the Amarillo Cereal Field Station, it has shown no adaptation for the dry lands.

It is too tall, too late in maturing, and too poor a yielder of grain to be of commercial value, even under conditions more favorable than those of the Texas Panhandle. Some popular interest still attaches to it, and for this reason it has been carried in the experiments during the entire nine years. The results obtained are shown in Table XXIX and comparatively in Table XXX and prove how poor it is under such conditions. Even in 1915 it was unable to make a better yield than 35 bushels per acre.

TABLE XXIX.—*Agronomic data for Guinea kafir grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
73	.....	.....	96	45	141	.....	.....	7.5	.....	.....	.....	.....	.....	.....
1910:														
73	28.0	8.8	[a] 90	53	143	68.1	.....	6.5	.....	.....	.....	.....	.....	.....
1911:														
73	.....	.....	[a] 106	.....	.....	.....	.....	6.0	.....	.....	.....	.....	.....	.....
1912:														
73	16.5	6.1	111	36	147	62.9	32.4	5.5	6.2	3.6	59.1	13,650	850	8.4
484	23.3	9.4	111	32	143	59.5	61.9	4.5	14.8	8.7	59.1	8,338	1,238	12.1
Average	19.9	7.7	111	34	145	61.2	47.1	5.0	10.5	6.2	59.1	10,994	1,044	10.2
1913:														
73	9.5	4.9	.....	.....	.....	48.0	.....	2.0	.....	.....	.....	.....	.....	.....
484	11.1	6.5	.....	.....	.....	41.2	.....	2.0	.....	.....	.....	.....	.....	.....
Average	10.3	5.7	.....	.....	.....	44.6	.....	2.0	.....	.....	.....	.....	.....	.....
1914:														
73	9.8	5.6	87	35	122	44.2	3.9	5.0	3.4	2.4	.....	4,120	175	2.1
1915:														
73	12.0	6.3	107	53	160	47.7	93.5	7.5	.....	.....	.....	.....	.....	35.0
1916:														
73	36.0	16.0	128	.....	.....	54.4	.....	3.5	.....	.....	.....	1,700	.....	.....

[a] First and only heads.

COMPARATIVE YIELDS OF THE KAFIR GROUP.

The annual and average acre yields of the leading races in each variety of the kafir group are given in Table XXX. The average yields are given for the 7-year, the 8-year, and the full 9-year periods. The table contains yields of 17 lots, of which 5 are Blackhull, 1 Sunrise, 1 Dawn (dwarf), 1 White, 2 Red, and 7 new kafirs. Seven of the lots have been grown throughout the 9-year period.

In the seven years from 1910 to 1916, inclusive, the Dawn, the Sunrise, and C. I. No. 316, one of the new varieties, lead with average acre yields between 17.5 and 17.9 bushels, that of the Dawn variety being highest. A Red kafir (C. I. No. 356) stands next with an average acre yield of 16.5 bushels, and Blackhull (C. I. No. 71) ranks fifth with an average yield of 15.7 bushels per acre. In the 8-year period the same three varieties lead, and Blackhull (C. I. No. 71) again holds fifth place. Fourth place is taken by Blackhull (C. I. No. 335), the Red (C. I. No. 356) having been grown only seven years.

In the 9-year period, Dawn kafir still leads with an average acre yield of 18.8 bushels. Sunrise has been grown only eight years and Blackhull (C. I. No. 71) advances to second place with an average yield of 17.3 bushels. Third and fourth places are occupied by Blackhull selections, with average acre yields of 16.9 and 16.5 bushels,

respectively. Blackhull and Red selections tie for fifth place with average yields of 13.9 bushels.

The breeding of the early variety, Sunrise, and the early and dwarf variety, Dawn, is seen to be justified by the outstanding favorable results.

TABLE XXX.—*Annual and average acre yields of the leading varieties and races in each of the subgroups of the kafir group of grain sorghums grown at the Amarillo Cereal Field Station in most or all of the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds.]

Variety and C. I. No.	Annual yields (bushels).									Average yields.		
	1908	1909	1910	1911	1912	1913	1914	1915	1916	7 years, 1910 to 1916.	8 years, 1909 to 1916.	9 years, 1908 to 1916.
Blackhull:										*Bus.*	*Bus.*	*Bus.*	*Cwt.*
71	42.2	3.5	1.0	26.5	4.7	0	14.0	64.0	0	15.7	14.2	17.3	10.4
204	31.4	10.9	5.5	19.0	9.2	0	10.7	38.3	0	11.8	11.7	13.9	8.3
207	32.6	6.3	4.4	11.4	4.5	0	10.0	35.7	0	9.4	9.4	11.7	7.0
335	37.0	10.7	4.8	20.6	4.6	0	11.3	62.7	0	14.9	14.3	16.9	10.1
337	38.3	7.7	3.5	21.0	4.7	0	9.3	64.0	0	14.6	13.8	16.5	9.9
Sunrise:													
472	.....	10.8	7.6	21.4	8.0	0	10.4	56.0	9.3	17.5	15.4	.....	.....
Dawn (dwarf):													
340	29.0	14.4	9.3	34.9	9.6	0	14.7	53.3	3.7	17.9	17.5	18.8	11.3
White:													
370	.....	.....	8.8	23.7	13.5	0	14.3	37.3	4.0	14.5	.....	.....	.....
Red:													
34	36.4	4.0	5.2	18.7	3.0	0	13.3	44.3	0	12.1	11.1	13.9	8.3
356	.....	.....	7.5	24.3	11.2	0	15.8	57.0	0	16.5	.....	.....	.....
New African:													
291	.....	0	2.2	21.7	6.1	0	8.3	44.7	0	11.9	10.4	.....	.....
303	.....	0	0	29.8	3.5	0	7.7	51.0	0	13.1	11.4	.....	.....
316	.....	4.3	0	40.0	4.7	0	12.7	66.0	0	17.6	16.0	.....	.....
432	.....	.....	.....	.....	12.4	0	9.3	59.7	2.0	.....	.....	.....	.....
252	.....	.....	0	28.6	3.3	0	6.3	50.7	0	12.7	11.1	.....	.....
314	.....	9.6	5.7	25.2	11.8	0	6.0	46.7	0	13.6	13.1	.....	.....
321	.....	.....	5.3	23.0	4.5	0	6.7	54.7	0	13.5	.....	.....	.....

THE KAOLIANG GROUP.

The kaoliangs are grain-producing varieties of sorghum from China and Manchuria. The most important varieties have been separated by a simple key (p. 17). The group has been quite fully described by the senior writer [1] in a previous publication.

The kaoliangs are very diverse in height, earliness, and productiveness. So far, only one variety, the Manchu, has become commercially important in the United States. All have dry pithy stems, and many of them are fairly early, presumably with rather low water requirements. However, those which are early enough to be valuable have never been able to compete in yield with Dwarf milo, milo, Sunrise kafir, etc., except at the extreme northern edge of the sorghum belt, as in South Dakota. The varieties grown are presented in three subgroups, White, Blackhull, and Brown, in Tables XXXI to XXXVI, inclusive.

[1] Ball, C. R. The kaoliangs: A new group of grain sorghums. U. S. Dept. Agr., Bur. Plant Indus. Bul. 253, 64 p., 15 fig., 1 pl. 1913.

THE WHITE KAOLIANG SUBGROUP.

Only two varieties of white-glumed, white-kerneled kaoliang have been under experiment. Both were grown during the first six years, though the yield made by Mukden (C. I. No. 190) in 1908 is missing. Only the one variety was grown in each of the last three years. The chief disadvantage of the varieties has been their height, which ranged from 6 to 8 feet and made them subject to lodging in wet or windy weather. Nor have they been good yielders. The complete data obtained are presented in Table XXXI. Annual and average yields of the White and Blackhull subgroups are compared in Table XXXIII, while the yields of all three subgroups are compared in Table XXXVI.

TABLE XXXI.—*Agronomic data for White kaoliang grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
190	9.7	6.8	69	55	124	29.9	.....	6.7	.....	.....	.....	.....	.....	.....
272	7.5	5.7	67	29	96	24.0	.....	8.0	.....	.....	.....	.....	.....	18.1
Average.	8.6	6.3	68	42	110	26.9	.....	7.3	.....	.....	.....	.....	.....	18.1
1909:														
190	11.6	11.1	70	40	110	4 3.	.....	.....	.....	.....	.....	.....	.....	12.8
272	10.1	9.8	71	41	112	2.8	.....	.....	.....	.....	.....	.....	.....	15.7
Average.	10.8	10.4	70.5	40.5	111	3.5	.....	.....	.....	.....	.....	.....	.....	14.2
1910:														
190	19.3	10.3	78	40	118	46.8	90.7	6.5	47.6	27.7	58.4	2,540	1,210	12.2
272	12.8	7.5	90	28	118	41.2	76.7	6.7	.....	.....	.....	.....	.....	7.2
Average.	16.0	8.9	84	34	118	44.0	83.7	6.6	47.6	27.7	58.4	2,540,	1,210	9.7
1911:														
190	7.7	6.7	74	27	101	12.9	100	8.0	51.0	31.5	60.9	4,614	2,354	25.1
272	6.0	5.3	72	29	101	11.2	100	7.5	49.4	28.3	57.6	4,312	2,132	21.2
Average.	6.8	6.0	73	28	101	12.0	100	7.7	50.2	29.9	59.2	4,463	2,243	23.1
1912:														
190	7.2	6.6	84	37	121	7.6	92.3	6.0	34.0	13.2	37.4	3,680	1,253	8.4
272	7.0	5.7	84	37	121	17.9	87.2	6.5	41.8	22.6	54.1	4,720	1,973	18.4
Average.	7.1	6.1	84	37	121	12.7	89.7	6.2	37.9	17.9	45.7	4,200	1,613	13.4
1913:														
190	7.8	7.2	71	32	103	7.3	.....	3.5	.....	.....	.....	.....	.....	.....
272	7.0	6.5	71	32	103	7.5	.....	3.5	.....	.....	.....	.....	.....	.....
Average.	7.4	6.8	71	32	103	7.4	.....	3.5	.....	.....	.....	.....	.....	.....
1914:														
190	7.2	6.5	64	26	90	9.5	76.9	6.0	32.8	18.5	56.5	4,666	1,533	14.9
1915:														
190	41.9	28.8	68	44	112	31.3	82.2	8.0	30.9	20.9	67.7	3,820	1,180	13.8
1916:														
190	17.2	13.1	77	28	105	24.1	86.2	5.5	.....	10.6	.....	1,880	.....	3.4

Table XXXI shows that the duration of the growing period has varied from 90 days, in 1915, to 121 days, in 1912. Their earliness, therefore, is comparable to that of the milo group and indicates some promise of usefulness in this particular line.

The stand obtained has varied considerably in the different years. In 1910, when the spring was extremely dry, the stand was better than that of any of the kafirs or milos. The poorest stand was obtained in the wet spring of 1915, when each plant had 42 inches of space and the sucker production of 31.3 per cent reduced the stalk space to only 29 inches. Sucker production in 1910 averaged 44 per cent of the total number of stalks, while the percentage in 1915 was the next highest.

The yield of Mukden (C. I. No. 190) is only 11.3 bushels per acre in the eight years for which the record exists, there being no record in 1908. The average acre yields of the two varieties in the five years from 1909 to 1913, inclusive, in which both were grown, were only 11.7 and 12.5 bushels, respectively. These yields are too small to be very encouraging. The yield of No. 190 in 1915, the year of bumper yields, was only 13.8 bushels per acre, due partly to the very thin stand, no doubt, but not indicating high productiveness under favorable conditions. The annual and 9-year average yields of White kaoliang are compared with those of other kaoliangs in Table XXXVI.

THE BLACKHULL KAOLIANG SUBGROUP.

This subgroup of kaoliangs is distinguished by black glumes and white kernels. Three different introductions have been under experiment in varying numbers of years in the 9-year period from 1908 to 1916, inclusive. The results are given in Tables XXXII and XXXIII. Only one of these varieties has proved at all promising. Brill (C. I. No. 120) was too tall to be satisfactory and too late to make good yields and was discarded at the end of six years. Korean (C. I. No. 412) also was tall and late and frequently gave only thin stands. It was placed in the experiment in 1910, continued for five years, and discarded at the end of 1914. Only Barchet (C. I. No. 310) has been carried throughout the 9-year period.

The stands obtained from the Barchet variety have been unusually uniform. The 9-year average plant space has been only 8.4 inches. The closest spacing was 3 inches in 1914, and the widest spacing 14.2 inches in 1916. In the dry spring of 1910 and the wet spring of 1915 the plant spacings were 13.8 and 10.7 inches, respectively, much closer than in most of the milos and kafirs. The average stalk space has been only 5.5 inches. The closest spacing was 2.7 inches, in 1914, when the plant space was only 3 inches. The widest spacing was 8.2 inches, in 1909, when the plant space was 8.9 inches and only 7 per cent of suckers were produced. Tillering has been in direct proportion to stand except in the year 1909. The average production

of suckers has been about 28 per cent, or about 1 sucker to every 2.5 main stalks. The lowest production was 4.4 per cent, in 1914, and the highest was 56.4 per cent, in 1910. In no other year did the proportion exceed 1 sucker to each main stalk, though in 1916 this proportion was closely approximated.

TABLE XXXII.—*Agronomic data for Blackhull kaoliang grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yield per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
120	14.1	7.2	78	47	124	48.9	.....	7.9	.....	.....	.....	.....	.....	.....
310	9.7	6.0	74	26	100	38.2	.....	5.0	.....	.....	.....	.....	.....	43.1
Average.	11.9	6.6	76	36.5	112.5	43.5	.....	6.4	.....	.....	.....	.....	.....	43.1
1909:														
120	11.4	9.5	92	.....	.....	16.6	.....	.....	.....	.....	.....	.....	.....	.....
310	11.6	10.4	75	.....	.....	10.3	.....	.....	.....	.....	.....	.....	.....	9.4
310	10.9	10.1	72	.....	.....	7.3	.....	.....	.....	.....	.....	.....	.....	9.4
310	6.8	6.4	77	.....	.....	5.8	.....	.....	.....	.....	.....	.....	.....	9.4
310	6.2	5.9	81	.....	.....	4.8	.....	.....	.....	.....	.....	.....	.....	9.6
Average.	9.4	8.5	79.4	.....	.....	8.9	.....	.....	.....	.....	.....	.....	.....	9.4
1910:														
120	16.8	7.1	90	30	120	56.6	36.6	7.2	.....	.....	.....	.....	.....	1.8
310	13.8	6.0	90	21	111	56.4	65.3	4.2	38.1	18.0	47.3	2,766	1,053	8.6
412	23.7	10.1	85	34	110	57.3	80.3	7.0	.....	.....	.....	.....	.....	10.3
Average.	18.1	7.7	88.3	28.3	116.6	56.8	60.7	6.1	38.1	18.0	47.3	2,766	1,053	6.9
1911:														
120	15.1	10.0	73	35	108	33.8	100	7.0	49.5	28.2	58.4	3,965	1,915	19.3
412	11.4	6.4	78	30	108	43.3	100	7.0	38.9	21.3	55.1	4,337	1,687	16.0
310	5.7	4.6	73	35	108	18.5	100	5.3	55.9	34.3	61.3	5,333	2,984	31.6
310	6.6	4.3	73	35	108	34.0	100	5.3	48.2	28.2	58.7	6,310	3,045	30.7
310	6.0	4.3	73	35	108	29.3	100	5.3	61.0	36.6	60.0	4,750	2,900	30.0
Average.	8.9	5.9	74	34	108	31.8	100	5.9	50.7	29.7	58.7	4,979	2,506	25.3
1912:														
120	6.4	4.8	87	34	121	25.3	14.7	6.0	43.5	21.1	48.3	4,200	1,830	15.3
412	22.9	6.4	87	34	121	72.5	100.0	6.0	49.0	25.8	52.6	4,060	1,993	18.1
310	5.3	4.0	84	26	110	23.7	87.2	4.0	46.4	26.1	56.2	4,030	1,873	18.2
310	3.6	3.3	87	23	110	8.3	76.3	4.0	37.6	18.2	42.2	3,900	1,470	12.2
310	3.4	3.2	91	19	110	5.8	76.4	4.0	39.9	18.8	47.1	3,980	1,590	12.9
Average.	8.3	4.3	87	27	114	27.1	82.9	4.8	43.2	22.0	49.3	4,034	1,751	15.3
1913:														
120	5.9	4.9	71	25	96	16.8	.....	2.5	.....	.....	.....	.....	.....	.....
412	9.8	6.1	75	33	108	37.3	.....	2.5	.....	.....	.....	.....	.....	.....
310	6.4	5.0	75	27	102	21.7	.....	2.5	.....	.....	.....	.....	.....	.....
310	6.2	4.8	75	27	102	22.0	.....	2.5	.....	.....	.....	.....	.....	.....
Average.	7.1	5.2	74	28	102	24.4	.....	2.5	.....	.....	.....	.....	.....	.....
1914:														
310	3.0	2.7	71	25	96	4.4	34.3	4.0	.....	11.1	.....	3,240	.....	6.2
412	4.0	3.8	66	30	96	6.2	50.5	4.5	34.4	13.3	38.7	4,500	1,550	10.4
Average.	3.5	3.3	68.5	27.5	96	5.2	42.4	4.3	34.4	12.2	38.7	3,870	1,550	8.3
1915:														
310	10.7	6.3	65	38	103	41.3	94.8	5.3	52.6	39.3	74.7	6,760	3,560	45.8
412	22.6	9.3	68	41	109	58.8	94.1	7.0	.....	.....	.....	5,333	.....	32.2
Average.	16.7	7.8	67	39	106	50.0	94.5	6.1	52.6	39.3	74.7	6,046	3,560	39.0
1916:														
310	14.2	7.5	77	47	124	47.2	43.2	3.0	.....	9.4	.....	2,120	.....	3.4

Barchet kaoliang is fairly early in maturing. The data cover only eight years, the record of 1909 being incomplete. The average duration of the vegetative period is 76.5 days, of the fruiting period 30.5 days, and of the entire growing period only 107 days. This period is of about the same length as that of milo and Dwarf milo, but is more than two weeks shorter than that of even the earliest kafir. The shortest growing period recorded is 96 days, in 1914, when the duration of the vegetative period was only 71 days and the fruiting period only 25 days. In that year, however, only the earliest heads appeared. The longest growing period recorded is 124 days, in 1916, when the vegetative period occupied only 77 days, but the fruiting period was prolonged by drought to 47 days, the longest yet recorded for this variety. The shortest fruiting period was 21 days, in 1910, correlated, however, with the longest vegetative period, or 90 days. The shortest vegetative period was 65 days, in 1915, a year of abundant moisture, in which this variety ripened in 103 days, while most of the grain sorghums required more than their average time in which to mature.

The average height of the Barchet kaoliang is 4.3 feet under the conditions obtaining at Amarillo in the last nine years. The lowest stature in any year in which grain matured was 3 feet, in 1916. The tallest growth was made in 1911 and 1915, when its height was 5.3 feet.

TABLE XXXIII.—*Annual and average acre yields of all lots of White and Blackhull kaoliang grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Subgroup and varieties.	C. I. No.	Annual yields (bushels).									Average yields.			
											6 years—		8 years, 1909 to 1916.	
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1908 to 1913.	1910 to 1915.		
White:											*Bus.*	*Bus.*	*Bus.*	*Cwt.*
Mukden	190	.....	12.8	12.2	25.1	8.4	0	14.9	13.8	3.4	.....	12.4	11.3	6.6
Do	272	18.1	15.7	7.2	21.2	18.4	0	.....	.....	.....	13.4	.....	.....	.....
Blackhull:														
Brill	120	.....	.....	1.8	19.3	15.3	0	.....	.....	.....	.....	.....	.....	.....
Barchet	310	43.1	[a]9.4	8.6	[a]30.7	[a]14.4	0	6.2	45.8	3.4	17.7	17.6	14.8	8.7
Korean	412	.....	.....	10.3	16.0	18.1	0	10.4	32.2	.....	.....	14.3	.....	.....

[a] Average of three plats.

The annual and average acre yields of Barchet kaoliang in the 9-year period are shown in Table XXXIII, compared with those of White kaoliang. The 9-year average yield has been 18 bushels, based on the records of 16 plats. This average yield is from 4 to 10 bushels lower than those of the milos and feterita, is a little lower than those of White durra and Dawn kafir, and is better than those of either Blackhull or Red kafir. Barchet kaoliang was able to make a small

yield in 1916, when the later kafirs did not produce any grain. The highest yield made was 45.8 bushels, in 1915. Many of the grain sorghums made much better yields in that year. The lowest yield, excepting the failure of 1913, was 3.4 bushels, in 1916. In 1911 this variety made the very good yield of 30.8 bushels as the average of three plats. The annual and average yields of the Barchet are compared with those of leading varieties of the White and Brown subgroups in Table XXXVI.

THE BROWN KAOLIANG SUBGROUP.

The Brown kaoliang subgroup contains a numerous collection of very diverse varieties. Some are early, some midseason, and some late. Some are dwarf, some midsized, and some tall. Some have very compact heads; others have open and spreading panicles. All are introductions from China and Manchuria. Almost all of them were mixed when received, and many of them contained hybrids, probably due to their having been grown in mixtures in their native land.

Those varieties which the preliminary experiments showed to have some promise for American conditions have been carefully selected and better races developed. For the most part, however, they have not been able to compete with the milo and kafir varieties in yield. No less than 33 varieties and selections of these brown-seeded kaoliangs have been grown. There were 19 when the experiment was begun in 1908. The maximum number in any one year was 23, in 1913, and the smallest number grown was 8, in 1915 and 1916. The results obtained are presented in Tables XXXIV and XXXV.

Since the varieties included in this subgroup are so very diverse, it is impossible to interpret their performance and value by a discussion of average results. It is possible, however, to present the average results obtained from two or three of the best varieties. The most promising of all, and the only one that has any commercial importance, is Manchu (C. I. No. 171). It was obtained from Japan, but without any doubt is a native of Manchuria, whence other almost identical forms have been derived. Figure 11 shows a plat of Manchu kaoliang (C. I. No. 171) grown at Amarillo, Tex., in 1908.

The most prominent characteristic of Manchu kaoliang has been its earliness. In 1908, a fairly normal season, it matured in 89 days, of which the vegetative period occupied 62 and the fruiting period 27 days. The only other variety as early was C. I. No. 261, an almost identical form of this variety, but not as good a yielder. The shortest growing period was 80 days, in 1914, and the next was 83 days, in 1909. In these two years the yields were 20 and 18.1 bushels per acre, respectively. The average duration of the growing period has been 93 days, of which an average of 65 days has been occupied by

the vegetative period and 28 days by the fruiting period. The shortest vegetative period was 60 days, in 1914, and the shortest fruiting period 19 days, in 1909, a very dry year. The longest vegetative period was 73 days, in 1912, and the longest fruiting period 36 days, in 1910, a very dry year, and again in 1915, a very wet season. It is noteworthy that in 1909 three selections matured in 83 days, while four others required 91 days, the difference being wholly in the fruiting period and caused perhaps more by the thinner stand of the latter than by any other reason. The average stalk space in the

FIG. 11.—A Plat of Manchu kaoliang (C. I. No. 171) at the Amarillo Cereal Field Station, August 20, 1908

three early lots was 3.4 inches, while in the four later lots it was 9.1 inches.

The stand obtained from Manchu kaoliang has been remarkably uniform. The closest spacing has been 3.4 inches and the widest 25.5 inches, which occurred in 1916. In 1910 the spacing was one plant to each 14 inches. Only in these two years did the spacing exceed 8 inches. The 9-year average plant space was only 8.7 inches. In the eight years, omitting 1916, the stalk space ranged from 3.4 inches to 7.1 inches. In that year, when the plant space was 25.5 inches, the stalk space was reduced only to 17.7 inches by the 30.8 per cent of suckers produced. The average stalk space in the nine years was 6.5 inches.

TABLE XXXIV.—*Agronomic data for Brown kaoliang grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
122-2	8.0	6.7	75	28	103	16.3	.....	5.6	.....	.....	.....	.....	.....	33.9
122-3	.....	.....	75	28	103	.....	.....	5.6	.....	.....	.....	.....	.....	.....
123-1	9.0	7.4	75	29	104	17.6	.....	6.5	.....	.....	.....	.....	.....	31.3
123-2	.....	.....	75	29	104	.....	.....	6.5	.....	.....	.....	.....	.....	.....
171-A	7.5	6.4	63	27	90	14.6	.....	5.0	.....	.....	.....	.....	.....	37.4
171-B	7.4	6.0	62	27	89	18.9	.....	4.5	.....	.....	.....	.....	.....	28.2
171-C	6.4	5.1	62	27	89	20.3	.....	5.0	.....	.....	.....	.....	.....	34.6
171-10	7.4	6.0	62	27	89	18.9	.....	5.0	.....	.....	.....	.....	.....	.....
171-12	.....	.....	62	27	89	.....	.....	5.0	.....	.....	.....	.....	.....	.....
191	8.3	7.4	68	27	95	10.8	.....	5.5	.....	.....	.....	.....	.....	.....
192	8.8	8.0	68	26	94	9.0	.....	6.0	.....	.....	.....	.....	.....	25.6
193	8.7	8.0	68	27	95	8.0	.....	6.0	.....	.....	.....	.....	.....	26.3
261	8.7	6.7	62	23	85	11.5	.....	6.0	.....	.....	.....	.....	.....	20.9
263	.....	.....	62	33	95	.....	.....	6.0	.....	.....	.....	.....	.....	.....
265	.....	.....	62	28	90	.....	.....	5.0	.....	.....	.....	.....	.....	.....
152	.....	.....	73	29	102	.....	.....	7.0	.....	.....	.....	.....	.....	.....
273	7.9	3.4	67	31	98	56.9	.....	7.0	.....	.....	.....	.....	.....	.....
293	.....	.....	73	40	113	.....	.....	2.5	.....	.....	.....	.....	.....	33.6
309	8.0	4.9	73	26	99	38.7	.....	6.0	.....	.....	.....	.....	.....	37.4
Average	8.0	6.3	67.7	28.3	96.1	20.1	.....	5.5	.....	.....	.....	.....	.....	30.9
1909:														
122-2	12.7	12.5	70	28	98	1.5	.....	.....	.....	.....	.....	.....	.....	14.4
122-3	11.1	11.0	70	28	98	.9	.....	.....	.....	.....	.....	.....	.....	15.1
123	10.0	9.9	70	28	98	1.0	.....	.....	.....	.....	.....	.....	.....	9.9
171-1	9.1	9.0	63	29	92	1.1	.....	.....	.....	.....	.....	.....	.....	14.3
171-2	9.4	9.2	64	28	92	2.1	.....	.....	.....	.....	.....	.....	.....	11.8
171-9	8.9	8.9	64	26	90	0	.....	.....	.....	.....	.....	.....	.....	9.7
171	4.0	3.9	64	19	83	2.5	.....	.....	.....	.....	.....	.....	.....	16.2
171	3.3	3.3	64	19	83	0	.....	.....	.....	.....	.....	.....	.....	15.3
171	3.0	3.0	64	19	83	0	.....	.....	.....	.....	.....	.....	.....	22.8
171-9-10	9.5	9.4	64	26	90	1.0	.....	.....	.....	.....	.....	.....	.....	9.1
193	11.5	11.3	66	27	93	1.7	.....	.....	.....	.....	.....	.....	.....	12.8
261	8.3	8.2	59	21	80	1.2	.....	.....	.....	.....	.....	.....	.....	11.4
293	11.2	11.1	66	33	99	.9	.....	.....	.....	.....	.....	.....	.....	3.5
309	9.0	8.5	66	25	91	5.5	.....	.....	.....	.....	.....	.....	.....	16.0
323	.....	.....	87	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
324	.....	.....	83	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
326	.....	.....	80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
327	.....	.....	67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
328	.....	.....	51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Average	8.6	8.5	67.4	25.4	90.7	1.4	.....	.....	.....	.....	.....	.....	.....	10.8
1910:														
122	19.3	8.8	76	35	111	54.6	82.0	4.7	49.4	24.9	50.4	2,726	1,346	11.7
123	12.8	6.6	80	31	111	48.5	70.5	4.7	31.6	12.0	38.0	3,145	995	6.5
171	16.9	8.0	61	36	97	52.5	100.0	5.5	59.3	38.0	64.0	2,600	1,543	17.0
171	11.6	6.2	61	36	97	46.6	100.0	4.7	55.5	36.0	64.9	2,699	1,499	16.8
171-9	33.1	19.2	78	25	103	41.9	a117.4	4.7	49.4	27.4	55.4	2,010	993	9.5
193	41.0	17.4	75	36	111	57.6	94.5	4.5	59.4	33.0	56.0	1,736	1,031	10.0
261	43.4	23.9	56	36	92	44.9	a106.8	5.2	46.8	25.1	53.6	1,424	666	6.2
293	13.9	8.5	80	31	111	39.1	69.2	2.7	50.5	18.3	38.1	2,102	1,062	6.6
309	37.0	11.8	77	40	117	68.2	95.8	5.5	65.1	33.7	51.6	2,494	1,624	14.5
309	42.1	12.0	77	40	117	71.4	96.8	5.0	62.5	36.7	58.7	2,460	1,537	15.6
324	15.8	6.0	90	21	111	62.1	63.3	4.7	49.2	26.5	54.6	.....	.....	6.5
326	10.2	3.9	90	23	113	61.3	43.2	6.0	.....	.....	.....	.....	.....	5.8
327	14.4	5.7	78	33	113	60.6	82.1	7.0	.....	.....	.....	.....	.....	8.2
328	24.7	15.8	60	26	86	36.2	a102.8	5.2	.....	.....	.....	1,630	793	7.5
413	27.3	19.3	92	21	113	29.3	91.5	5.8	.....	.....	.....	.....	.....	10.6
414	25.6	7.3	89	40	129	71.5	84.2	6.7	.....	.....	.....	.....	.....	8.3
421	11.2	5.7	80	28	108	49.0	92.0	6.0	.....	.....	.....	.....	.....	14.3
423	22.0	13.5	83	34	117	38.5	76.1	7.0	.....	.....	.....	.....	.....	6.3
424	26.9	16.6	80	28	108	38.5	88.5	6.0	.....	.....	.....	.....	.....	14.2
Average	23.6	11.4	77	31.5	108.6	51.1	87.2	5.3	52.6	28.3	53.2	2,275	1,189	10.3

a Includes mature heads on branches.

TABLE XXXIV.—*Agronomic data for Brown kaoliang grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1911:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
123	11.0	7.4	72	37	109	33.1	.....	7.0	57.3	36.6	64.2	4,330	2,485	27.5
193	11.4	10.8	66	30	96	5.3	.....	5.8	56.3	37.4	66.5	3,880	2,185	25.1
171	7.1	5.7	66	29	95	19.2	.....	6.5	56.9	35.7	62.6	4,760	2,710	29.3
261	8.7	7.7	63	29	92	11.6	.....	6.5	45.1	27.7	61.4	3,856	1,740	18.4
261	8.9	7.7	63	29	92	13.0	.....	6.5	44.5	26.6	60.4	3,356	1,496	15.6
328	5.8	5.5	60	31	91	5.1	.....	5.6	52.0	28.9	55.6	3,830	1,995	19.2
328	6.2	5.9	61	30	91	3.6	.....	6.5	51.9	37.7	72.7	3,610	1,875	23.5
324	4.3	3.5	73	37	110	18.4	.....	5.5	45.1	24.5	54.3	5,035	2,275	21.3
326	4.8	3.9	85	25	110	17.7	.....	6.5	33.6	19.3	57.5	5,635	1,895	18.8
327	6.6	5.4	71	25	96	17.9	.....	8.0	46.0	28.4	61.2	4,031	1,856	19.8
376	20.0	6.5	92	18	110	67.5	.....	6.3	18.2	5.1	28.0	5,875	1,075	5.2
277	10.7	4.2	92	18	110	60.7	.....	5.5	37.2	15.0	40.0	5,262	1,962	13.7
278	7.3	4.2	83	27	110	42.7	.....	7.0	46.5	21.9	47.0	5,987	2,787	22.6
122	8.1	7.1	71	30	101	12.3	.....	5.8	56.4	35.6	63.7	4,364	2,454	26.9
293	9.6	8.3	71	30	101	13.8	.....	3.5	65.2	40.8	62.6	3,917	2,557	27.6
309	11.9	6.2	71	41	112	47.5	.....	6.5	58.9	35.6	60.3	5,047	2,977	31.0
413	10.5	7.3	71	27	98	30.6	.....	6.0	40.4	31.0	76.7	4,956	2,006	26.5
414	9.1	4.3	83	36	119	52.5	.....	8.0	29.5	13.9	47.2	7,025	2,075	16.9
421	8.3	4.5	68	44	112	45.4	.....	6.3	61.0	29.6	48.6	4,493	2,743	22.9
423	7.5	6.8	68	42	110	9.3	.....	8.0	51.3	30.0	58.4	4,725	2,425	24.4
424	5.7	5.1	68	28	96	10.2	.....	6.3	55.8	32.6	58.3	4,984	2,784	28.0
Average.	8.7	6.1	72	30.6	102.9	25.6	.....	6.3	48.0	28.2	57.4	4,712	2,207	22.1
1912:														
123	4.9	4.5	84	37	121	7.1	72.6	5.0	30.8	12.8	40.0	4,340	1,340	9.3
193	5.9	5.7	76	22	98	3.7	96.2	4.5	33.9	18.2	53.6	4,860	1,650	15.3
171	3.0	2.9	73	25	98	3.3	96.2	5.0	44.7	25.4	56.9	4,430	1,983	19.5
261	4.1	4.0	66	28	94	2.1	98.0	4.3	47.6	28.3	59.5	3,340	1,590	16.3
328-1	5.4	5.3	57	34	91	1.0	98.9	4.0	56.1	33.6	59.6	2,600	1,460	15.1
328-2	5.3	5.3	57	34	91	.....	98.3	4.0	56.9	35.7	62.9	2,380	1,355	14.7
328	3.9	3.9	67	27	94	.....	98.3	4.3	51.1	29.9	58.5	3,030	1,550	15.6
324	5.2	4.0	87	34	121	23.2	66.0	4.8	38.1	16.0	42.0	4,540	1,730	12.5
326	2.9	2.6	94	28	122	8.2	39.2	6.0	16.5	6.0	36.3	5,180	855	5.4
327	2.2	2.1	87	28	115	4.4	61.2	7.0	27.1	8.6	31.7	4,000	1,088	6.0
276	7.0	3.6	104	25	129	48.8	6.6	5.8	2.2	.7	31.9	5,269	119	.7
277	8.1	3.1	104	25	129	61.9	8.7	5.0	4.5	1.2	28.6	4,820	219	1.1
278	2.1	2.0	118	34	152	4.6	61.4	6.0	28.9	10.0	34.7	5,600	1,619	9.7
122	4.1	3.8	84	37	121	6.4	89.6	5.0	35.9	13.3	37.0	4,480	1,610	10.3
293	3.9	3.8	87	34	121	2.1	87.2	3.0	29.6	8.8	29.8	3,380	1,003	5.2
309	4.0	3.6	87	34	121	8.6	76.7	4.8	33.9	16.1	47.5	4,010	1,360	11.2
413	5.7	4.7	87	28	115	17.6	79.6	5.0	29.4	11.4	38.7	4,460	1,313	8.8
414	4.0	3.6	94	30	124	8.4	44.7	6.0	10.8	5.8	53.7	4,746	512	4.7
421	4.8	3.1	76	28	104	34.6	92.2	4.5	50.1	26.9	53.7	3,900	1,958	18.1
423	3.7	3.6	76	28	104	3.7	94.5	5.5	44.4	25.8	58.3	4,475	1,988	20.0
424	3.9	3.6	71	27	98	6.0	94.9	4.5	50.5	31.0	61.4	4,760	2,408	25.5
475	39.6	22.3	71	33	104	43.6	61.4	5.5	58.8	39.4	67.0	1,700	1,000	12.8
Average.	6.1	4.6	82	30	112	13.6	73.7	4.9	35.5	18.4	47.4	4,104	1,350	11.7
1913:														
123	8.0	7.2	72	30	102	10.0	.....	3.0	.....	.....	.....	.....	.....	.....
193	12.1	11.4	64	29	93	5.2	.....	3.5	.....	.....	.....	.....	.....	.....
171	7.0	6.7	64	30	94	4.4	.....	3.5	.....	.....	.....	.....	.....	.....
261	4.3	4.2	64	38	92	2.8	.....	3.5	.....	.....	.....	.....	.....	.....
328	4.4	4.3	56	36	92	.8	.....	3.5	.....	.....	.....	.....	.....	.....
328-1	3.4	3.4	53	34	87	.3	.....	3.5	.....	.....	.....	.....	.....	.....
328-2	3.7	3.6	53	34	87	.2	.....	3.5	.....	.....	.....	.....	.....	.....
324	3.5	3.1	74	28	102	9.5	.....	3.0	.....	.....	.....	.....	.....	.....
326	3.6	3.2	87	.....	.....	11.1	.....	3.0	.....	.....	.....	.....	.....	.....
327	8.1	6.4	71	31	102	20.5	.....	4.5	.....	.....	.....	.....	.....	.....
276	4.8	3.5	.....	.....	.....	27.9	.....	2.5	.....	.....	.....	.....	.....	.....
277	3.9	2.8	.....	.....	.....	27.0	.....	2.5	.....	.....	.....	.....	.....	.....
278	3.1	2.8	75	27	102	7.5	.....	3.0	.....	.....	.....	.....	.....	.....
122	5.3	5.1	75	27	102	5.0	.....	3.0	.....	.....	.....	.....	.....	.....
293	4.3	4.3	75	27	102	2.2	.....	2.5	.....	.....	.....	.....	.....	.....
309	5.4	4.7	70	25	95	14.3	.....	3.0	.....	.....	.....	.....	.....	.....
413	6.5	5.9	71	24	95	8.7	.....	3.0	.....	.....	.....	.....	.....	.....
414	3.4	2.9	101	.....	.....	4.0	.....	3.0	.....	.....	.....	.....	.....	.....
421	2.4	2.3	71	24	95	4.2	.....	3.0	.....	.....	.....	.....	.....	.....
423	4.5	4.2	71	31	102	5.1	.....	3.0	.....	.....	.....	.....	.....	.....
424	4.3	4.1	64	28	92	4.5	.....	3.0	.....	.....	.....	.....	.....	.....
475	3.8	3.6	64	28	92	4.4	.....	3.5	.....	.....	.....	.....	.....	.....
503	3.8	3.7	71	24	95	29.2	.....	3.0	.....	.....	.....	.....	.....	.....
Average.	4.9	4.5	69	28	97	9.5	.....	3.1	.....	.....	.....	.....	.....	.....

TABLE XXXIV.—*Agronomic data for Brown kaoliang grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive*—Continued.

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1914:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
171	6.5	5.1	60	20	80	21.9	97.5	5.3	57.5	35.1	61.0	3,300	1,900	20.0
261	3.2	3.2	53	20	73	.8	94.1	5.5	58.7	30.7	52.3	2,860	1,680	15.2
328	3.2	3.1	52	22	74	.4	94.5	5.8	66.9	31.7	47.5	2,900	1,940	15.9
328–1	3.1	3.1	51	21	72	.0	97.3	5.8	68.6	37.3	54.4	3,000	2,060	19.3
324	2.0	1.9	71	25	96	.5	34.3	4.0	25.3	9.5	37.6	5,440	1,380	9.0
293	4.0	3.9	64	32	96	.3	64.3	3.0	.....	25.9	.....	2,780	.....	12.4
413	4.0	3.9	60	29	89	.3	77.9	4.8	50.9	28.0	55.0	4,280	2,180	20.7
421	3.6	2.5	58	27	85	.3	66.2	4.5	50.8	24.5	48.2	3,800	1,933	16.0
423	3.4	3.4	58	29	87	1.0	68.5	5.8	57.1	31.7	55.5	3,150	1,800	17.2
424	2.2	2.1	56	29	85	.2	81.9	5.3	47.0	24.0	51.0	5,000	2,350	20.7
475	4.1	4.2	56	29	85	.6	79.5	5.3	52.0	30.6	58.8	3,166	1,700	17.2
Average.	3.5	3.3	58	25.7	83.8	2.4	77.8	5.0	48.6	28.0	47.4	3,606	1,892	16.7
1915:														
171	4.0	3.8	67	36	103	4.3	92.9	6.5	.....	.....	.....	.....	.....	46.6
261	4.7	4.2	62	32	94	9.4	92.1	6.5	.....	.....	.....	.....	.....	29.0
328	7.6	7.1	62	32	94	6.7	96.6	6.5	.....	.....	.....	.....	.....	24.8
328–1	6.5	6.3	56	38	94	2.3	98.5	5.8	.....	.....	.....	.....	.....	21.5
324	4.7	4.2	76	43	119	10.7	92.7	5.0	42.3	26.1	61.7	7,800	3,300	35.2
293	7.2	6.9	71	39	110	3.8	96.7	3.8	57.3	38.8	67.8	5,760	3,300	38.6
413	6.8	5.3	71	48	119	21.6	97.0	5.5	.....	.....	.....	.....	.....	48.6
424	4.7	4.4	67	52	119	5.8	100.0	5.5	.....	.....	.....	.....	.....	38.9
Average.	5.8	5.3	66	40	106	8.1	95.8	5.6	.....	.....	.....	.....	.....	35.4
1916:														
171	25.5	17.7	70	27	97	30.8	86.2	4.0	.....	35.1	.....	1,080	.....	6.6
261	9.9	8.3	59	23	82	15.7	65.5	3.3	.....	34.8	.....	920	.....	5.5
328	13.6	10.9	58	30	88	19.7	73.6	3.0	.....	35.7	.....	840	.....	5.2
328–1	13.0	11.4	57	24	81	12.4	78.7	3.3	.....	35.7	.....	560	.....	3.4
324	10.0	6.3	84	51	135	37.1	45.2	3.5	.....	10.0	.....	2,400	.....	4.1
293	16.2	13.1	84	51	135	19.1	42.2	2.3	.....	8.6	.....	1,160	.....	1.7
413	13.0	8.6	83	35	118	33.5	39.1	3.5	.....	8.1	.....	1,980	.....	2.7
424	17.8	13.1	75	43	118	26.4	73.7	3.8	.....	18.7	.....	960	.....	3.1
Average.	14.9	11.2	71.2	35.5	106.7	24.3	63.0	3.4	.....	23.3	.....	1,237	.....	4.0

Manchu kaoliang does not tiller as freely as most of the grain sorghums. The largest percentage of suckers produced was 49.5 per cent, in 1910, when the plant space was 14.2 inches. This was one sucker to each main stalk and reduced the stalk space to 7.1 inches. The average height of this variety has been 5.1 feet and the variation from 3.5 feet, in 1913, to 6.5 feet, in 1911 and 1915.

The annual and average acre yields of leading Brown kaoliangs are brought together in Table XXXV, and the acre yields of the leading varieties in all three subgroups are compared in Table XXXVI. The 9-year average acre yield of Manchu kaoliang has been 21.2 bushels. This exceeds the yield of any of the kafirs or White durra, but falls just below those of Alba milo and feterita. It is about 3 bushels below the average yield of milo and about 7 bushels below that of Dwarf milo. Although this kaoliang failed completely in 1913, as did all the grain sorghums, it has given better yields in the other dry years than most of the varieties. In 1916 its yield was 6.6

bushels. The next lowest yield was 16.9 bushels, in 1910, a very dry year. In 1915, the most favorable season of all, however, its yield was only 46.6 bushels per acre, which was 15 to 20 bushels lower than those of some of the best varieties in other grain-sorghum groups.

TABLE XXXV.—*Annual and average acre yields of Brown kaoliangs grown at the Amarillo Cereal Field Station during periods of varying length in the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Variety.	C. I. No.	Annual and average acre yield (bushels).												
		1908	1909	1910	1911	1912	1913	1914	1915	1916	4 years, 1910 to 1913.	6 years, 1908 to 1913.	7 years, 1910 to 1916.	9 years, 1908 to 1916.
Peesan	122	33.9	14.4	11.7	26.9	10.3	0	.....	.....	.....	12.2	16.2	.....	.....
Tientsin	123	31.3	9.9	6.5	27.5	9.3	0	.....	.....	.....	10.8	14.1	.....	.....
Manchu	171	[a]33.4	[a]18.1	17.0	29.3	19.5	0	20.0	46.6	6.6	16.5	19.6	19.9	21.2
Kali	193	26.3	12.8	10.0	25.1	15.3	0	.....	.....	.....	12.6	14.9	.....	.....
Manchu	261	20.9	11.4	6.2	18.4	16.3	0	15.2	29.0	5.5	10.2	12.2	12.9	13.7
Shantung	293	33.6	3.5	6.6	27.6	5.2	0	12.4	38.6	1.7	9.9	12.8	13.2	14.4
Valley	309	37.4	16.0	14.5	31.0	11.2	0	.....	.....	.....	14.2	18.4	.....	.....
Chusan	324	.....	.....	6.5	21.3	12.5	0	9.0	35.2	4.1	10.1	.....	12.7	.....
Hankow	326	.....	.....	5.8	18.8	5.4	0	.....	.....	.....	7.5	.....	.....	.....
Redstem	327	.....	.....	8.2	19.8	6.0	0	.....	.....	.....	8.5	.....	.....	.....
Manchu	328	.....	.....	7.5	19.2	15.6	0	15.9	24.8	5.2	10.6	.....	12.6	.....
Choonchun	413	.....	.....	10.6	26.5	8.8	0	20.7	48.6	2.7	11.5	.....	16.8	.....
Moose	414	.....	.....	8.3	16.9	4.7	0	.....	.....	.....	7.5	.....	.....	.....
Ware	421	.....	.....	14.3	22.9	18.1	0	16.0	.....	.....	13.8	.....	.....	.....
Valley	423	.....	.....	6.3	24.4	20.0	0	17.2	.....	.....	12.7	.....	.....	.....
Parker	424	.....	.....	14.2	28.0	25.5	0	20.7	38.9	3.1	16.9	.....	18.6	.....

[a] Average of three plats.

Two other races of Manchu kaoliang almost identical with C. I. No. 171 are C. I. Nos. 261 and 328. Of these, No. 261 has been grown throughout the whole nine years. It is usually from three to five days earlier than No. 171, but seldom germinates to as good a stand and does not yield as well. The 9-year average acre yield of C. I. No. 261 is only 13.5 bushels, while that of C. I. No. 171 is 21.2 bushels, or 7.7 bushels more. C. I. No. 328 was first grown in 1910. It is of about the same earliness as No. 261 and usually had about the same stand or a little poorer than that of No. 171. Its average acre yield in the 7-year period was 12.9 bushels, and that of No. 261 was 12.7 bushels, while that of No. 171 was 19.8 bushels. In the same seven years Shantung, No. 293, a very dwarf but stocky and later variety, produced 13.2 bushels. It is evident that while earlier in maturing, neither No. 261 nor No. 328 can compete with No. 171 in yield. No. 261 yielded 12.5 bushels less than No. 171 in 1908, a good year, and 17.6 less in 1915, a year of bumper yields, in which No. 328 yielded 21.8 bushels less than No. 171.

Another selection, C. I. No. 324, which is two to three weeks later than C. I. No. 171, has been grown during the last seven years. It was thought to be promising, but its average acre yield in that

time has been only 12.7 bushels, exactly the same as that of C. I. No. 261. In addition, it was able to make a yield of only 35.2 bushels in 1915, so it may be dropped from further consideration.

The two selections, C. I. Nos. 413 and 424, are fairly promising. They are about 10 days later than C. I. No. 171, but about equal to it in height. Both have been grown only during the last seven years, and their average acre yields in that time have been 16.8 and 18.6 bushels, respectively. The yield of No. 171 was 19.8 bushels in the same period, or 1.2 bushels more than that of No. 424. In 1915 the yield of No. 413 was 48.6 bushels and that of No. 424 was 38.9 bushels, the former exceeding the yield of No. 171 by 2 bushels in that year. Valley, C. I. No. 309, a variety about two weeks later and a little taller than No. 171, was grown during the first six years and produced an average acre yield of 18.4 bushels compared with 19.5 bushels from No. 171 in the same years. Nos. 261 and 293 yielded in the same years 12 and 12.7 bushels, respectively.

COMPARATIVE YIELDS OF ALL THE KAOLIANGS.

A survey of the comparative yields given in Table XXXVI shows that varieties of the brown-seeded kaoliangs have made the best average yields in both the 7-year and 9-year periods. In the 7-year period three brown-seeded sorts outyield the Barchet (blackhull), which in turn outyields the Mukden (white). In the 9-year period two of the high-yielding brown-kerneled sorts are not present, but the other three varieties maintain the same relative rank as before.

TABLE XXXVI.—*Annual and average acre yields of grain of the leading varieties and races in each of the subgroups of the kaoliang group of grain sorghums grown at the Amarillo Cereal Field Station in most or all of the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Subgroup and variety.	C. I. No.	Annual yields (bushels).									Average yields.		
		1908	1909	1910	1911	1912	1913	1914	1915	1916	7 years, 1910 to 1916.	9 years, 1908 to 1916.	
White:											*Bus.*	*Bus.*	*Cwt.*
Mukden	190	.....	12.8	12.2	25.1	8.4	0	14.9	13.8	3.4	11.1	.....	.....
Blackhull:													
Barchet	310	43.1	9.4	8.6	30.7	14.4	0	6.2	45.8	3.4	15.6	18.0	10.4
Brown:													
Manchu	171	33.4	18.1	17.0	29.3	19.5	0	20.0	46.6	6.6	19.9	21.2	12.3
	261	20.9	11.4	6.2	18.4	16.3	0	15.2	29.0	5.5	12.9	13.7	7.9
	328	.....	.....	7.5	19.2	15.6	0	15.9	24.8	5.2	12.6	.....	.....
Shantung	293	33.6	3.5	6.6	27.6	5.2	0	12.4	38.6	1.7	13.2	14.4	8.4
Chusan	324	.....	.....	6.5	21.3	12.5	0	9.0	35.2	4.1	12.7	.....	.....
Choonchun	413	.....	.....	10.6	26.5	8.8	0	20.7	48.6	2.7	16.8	.....	.....
Parker	424	.....	.....	14.2	28.0	25.5	0	20.7	38.9	3.1	18.6	.....	.....

The Shallu Group.

Shallu was introduced from India about 25 years ago and first grown in Louisiana. From there it was carried westward to Texas, where it is still sparingly grown. In the past 10 years it has been widely exploited [1] under fanciful and misleading names, such as "California Wheat," "Egyptian Wheat," "Old Mexico Desert Wheat-corn," etc.

TABLE XXXVII.—*Agronomic data for shallu grown at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 58 pounds.]

Year and C. I. No.	Row space.		Length of period.			Suckers.	Headed.	Height of plants.	Heads in crop.	Seed in—		Yields per acre.		
	Plants.	Stalks.	Vegetating.	Fruiting.	Total growing.					Crop.	Heads.	Total crop.	Heads.	Seed.
1908:	*Ins.*	*Ins.*	*Days.*	*Days.*	*Days.*	*P. ct.*	*P. ct.*	*Feet.*	*P. ct.*	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*Bus.*
85	10.1	3.8	78	.....	.....	62.3	.....	6.0	.....	.....	.....	.....	.....	.....
125	.....	.....	78	.....	.....	.....	.....	6.0	.....	.....	.....	.....	.....	.....
217	10.5	3.7	78	.....	.....	64.7	.....	6.0	.....	.....	.....	.....	.....	.....
Average	10.3	3.2	78	.....	.....	63.5	.....	6.0	.....	.....	.....	.....	.....	.....
1910:														
85	102.2	14.4	[a] 91	35	126	84.5	.....	6.0	.....	.....	.....	.....	.....	.....
125	24.6	5.9	[a] 91	34	125	76.1	.....	6.0	.....	.....	.....	.....	.....	.....
165	24.4	6.2	[a] 97	29	126	74.5	.....	6.0	.....	.....	.....	.....	.....	.....
217	30.2	7.2	[a] 97	29	126	80.8	.....	6.0	.....	.....	.....	.....	.....	.....
349	19.9	4.7	[a] 97	29	126	76.3	.....	6.5	.....	.....	.....	.....	.....	.....
383	54.6	12.4	[a] 61	51	128	77.2	64.0	5.7	.....	.....	.....	.....	.....	.....
387	33.7	17.0	[a] 91	51	142	49.5	66.7	5.5	.....	.....	.....	.....	.....	.....
380	23.3	5.7	.....	.....	.....	75.7	.....	.....	.....	.....	.....	.....	.....	.....
Average	39.1	9.2	89	36.8	128.4	74.3	65.3	5.2	.....	.....	.....	.....	.....	.....
1911:														
85	.....	.....	87	38	125	.....	.....	5.5	60.3	25.9	42.9	2,525	1,525	8.9
125	.....	.....	87	38	125	.....	.....	6.0	56.7	31.4	55.4	4,856	2,756	26.3
217	.....	.....	87	38	125	.....	.....	6.0	45.4	23.1	48.4	2,293	1,093	9.1
349	.....	.....	87	38	125	.....	.....	6.0	50.9	27.8	54.6	5,093	2,593	24.4
Average	.....	.....	87	38	125	.....	.....	5.8	53.3	27.0	50.3	3,692	1,992	17.2
1912:														
85	16.2	3.4	96	35	131	79.0	15.4	4.0	9.0	5.5	61.2	4,070	370	3.9
125	15.6	3.5	96	35	131	77.5	22.1	4.0	14.3	8.8	62.1	4,108	588	6.6
165	31.7	6.2	96	35	131	80.4	40.2	4.0	21.1	12.2	57.6	3,425	725	7.2
217	20.0	4.4	96	35	131	77.9	35.1	4.3	16.9	9.8	58.0	4,553	773	7.7
349	20.8	4.7	96	35	131	77.3	46.3	4.3	18.3	10.8	59.3	5,435	995	10.2
387	105.6	18.2	96	35	131	71.2	60.9	4.0	28.4	11.4	40.1	1,538	438	3.0
Average	34.9	6.7	96	35	131	77.2	36.6	4.1	18.0	9.7	56.4	3,855	648	6.4
1913:														
85	7.2	3.6	.....	.....	.....	49.2	.....	2.0	.....	.....	.....	.....	.....	.....
125	13.9	6.6	.....	.....	.....	54.1	.....	2.0	.....	.....	.....	.....	.....	.....
165	8.0	4.2	.....	.....	.....	47.8	.....	2.0	.....	.....	.....	.....	.....	.....
217	8.4	4.5	.....	.....	.....	51.5	.....	2.0	.....	.....	.....	.....	.....	.....
349	9.5	4.7	.....	.....	.....	50.3	.....	2.0	.....	.....	.....	.....	.....	.....
387	17.6	7.3	.....	.....	.....	58.8	.....	2.0	.....	.....	.....	.....	.....	.....
Average	10.7	5.1	.....	.....	.....	51.9	.....	2.0	.....	.....	.....	.....	.....	.....
1914:														
85	4.8	2.9	66	50	116	39.0	6.5	4.0	4.8	3.4	70.0	4,100	200	2.1
1915:														
85	12.6	5.2	88	55	143	59.2	.....	8.0	.....	.....	.....	.....	.....	34.5
1916:														
85	19.0	6.7	133	.....	.....	64.9	.....	3.5	.....	.....	.....	.....	.....	.....

[a] First and only heads.

[1] Ball, C. R. Three much-misrepresented sorghums. U. S. Dept. Agr., Bur. Plant Indus. Cir. 50, 14 p., 2 fig. 1910.

Rothgeb, B. E. Shallu, or "Egyptian wheat": A late-maturing variety of sorghum. U. S. Dept. Agr., Farmers' Bul. 827, 8 p., 2 fig. 1917.

It has been grown at Amarillo in all the nine years except 1909. The data resulting are presented in Table XXXVII. It has proved itself quite unfitted for the dry-land conditions obtaining in the Texas Panhandle, as is fully shown also in the publications cited. Its germination has been poor in nearly all years. It is tall and very late in maturing, frequently lodging in autumn storms and often failing to ripen. For these reasons the yields have been very low. In 1910, 1913, and 1916 it produced no grain at all. The production of suckers has always been high, and where adapted it is more likely to prove of value for forage than for grain

Comparative Yields of All the Groups.

The annual and average acre yields of the leading races in each variety of each group of grain sorghums are shown in Table

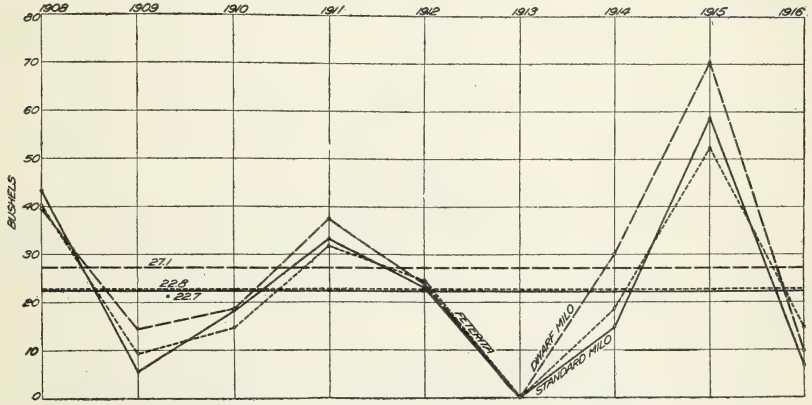

Fig. 12.—Diagram showing the annual and average acre yields, in 58-pound bushels, of standard milo, Dwarf milo, and feterita at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.

XXXVIII. The average yields are given first for the 7-year period, from 1910 to 1916, inclusive, in order to compare a few selections grown only in those years. The average yields in the full 9-year period from 1908 to 1916, inclusive, are given for all selections grown that long.

It will be noted from this table that Dwarf milo made the highest average yield of any subgroup in both the 7-year and the 9-year periods. Therefore it takes first place in grain production among the grain-sorghum groups. The best selection of Dwarf milo yielded an average of 27.2 bushels annually in the 7-year period and 27.1 bushels in the 9-year period. The average yield of Dwarf milo in both periods is approximately 5 bushels more than the average yield of any other variety. Figure 12 shows graphically the annual and average yields of milo, Dwarf milo, and feterita in the 9-year period from 1908 to 1916, inclusive, at Amarillo, Tex.

Milo, Alba milo, feterita, and Manchu kaoliang have average yields ranging from about 20 to 22 bushels in the 7-year period and from about 21 to 23 bushels in the 9-year period. These four varieties may be said to tie for second place in grain production. There is little choice between them except when their combined grain and fodder value is considered. Manchu kaoliang has less fodder value than the milos or feterita because of its drier and more slender stems and scanty foliage.

TABLE XXXVIII.—*Annuat and average acre yields of the best selections in all varieties and groups of grain sorghums grown at the Amarillo Cereal Field Station in most or all of the nine years from 1908 to 1916, inclusive.*

[In the statement of yields per acre the bushel is rated at 60 pounds for kafirs and at 58 pounds for all other sorghums.]

Group and variety.	C. I. No.	Annual and average acre yields (bushels).										
		1908	1909	1910	1911	1912	1913	1914	1915	1916	7 years, 1910 to 1916.	9 years, 1908 to 1916.
Milo-durra:												
Milo	223	37.4	16.5	18.8	24.4	23.6	0	12.8	64.8	7.6	21.7	22.9
Do	232	30.4	3.6	9.8	30.1	33.0	0	10.7	60.0	6.6	21.5	20.5
Do	234	43.2	5.8	18.2	33.3	23.3	0	14.8	58.6	6.9	22.2	22.7
Dwarf milo	149	42.6	12.4	20.8	36.8	13.3	0	30.0	74.1	7.6	26.1	26.4
Do	332	39.5	14.2	18.6	37.4	24.0	0	30.0	70.3	9.7	27.2	27.1
Do	359	.....	.....	20.0	37.3	34.6	0	16.2	68.3	8.6	26.4	.....
Alba milo	352	.....	.....	16.9	37.5	15.8	0	11.4	59.3	4.8	20.8	.....
Feterita	182	40.2	9.3	14.7	31.9	24.5	0	18.5	52.1	14.5	22.3	22.8
White durra	81	35.7	7.7	10.0	26.4	24.3	0	22.4	36.9	4.5	17.8	18.7
Durra-kafir hybrids:												
Black glumed	198–7–3	41.0	2.8	9.1	30.2	3.0	0	16.2	34.5	7.2	14.3	16.0
Do	198–15–3	27.4	7.8	5.4	39.9	4.1	0	20.7	24.5	2.4	13.9	14.7
White glumed	198–7–3	41.0	2.8	21.2	28.2	6.0	0	13.8	28.1	5.7	14.7	16.3
Do	198–15–3	27.4	7.8	16.0	34.1	11.6	0	14.8	17.9	1.7	13.7	14.6
Do	240	35.7	4.2	17.0	46.1	5.0	0	8.6	29.3	3.5	15.6	16.6
Do	240–6	35.7	4.2	17.0	30.3	11.5	0	19.3	36.2	3.5	16.8	17.5
Kafir:												
Blackhull	71	42.2	3.5	1.0	26.5	4.7	0	14.0	64.0	0	15.7	17.3
Do	335	37.0	10.7	4.8	20.6	4.6	0	11.3	62.7	0	14.9	16.9
Do	337	38.3	7.7	3.5	21.0	4.7	0	9.3	64.0	0	14.6	16.5
Sunrise	472	.....	10.8	7.6	21.4	8.0	0	10.4	56.0	9.3	17.5	.....
Dawn (dwarf)	340	29.0	14.4	9.3	34.9	9.6	0	14.7	53.3	3.7	17.9	18.8
White	370	.....	.....	8.8	23.7	13.5	0	14.3	37.3	4.0	14.5	.....
Red	34	36.4	4.0	5.2	18.7	3.0	0	13.3	44.3	0	12.1	13.9
Do	356	.....	.....	7.5	24.3	11.2	0	15.8	57.0	0	16.5	.....
New	316	.....	4.3	0	40.0	4.7	0	12.7	66.0	0	17.6	.....
Do	314	.....	9.6	5.7	25.2	11.8	0	6.0	46.7	0	13.6	.....
Kaoliang:												
Mukden	190	.....	12.8	12.2	25.1	8.4	0	14.9	13.8	3.4	11.1	.....
Barchet	310	43.1	9.4	8.6	30.7	14.4	0	6.2	45.8	3.4	15.6	18.0
Manchu	171	33.4	18.1	17.0	29.3	19.5	0	20.0	46.6	6.6	19.9	21.2
Shantung	293	33.6	3.5	6.6	27.6	5.2	0	12.4	38.6	1.7	13.2	14.4
Parker	424	.....	.....	14.2	28.0	25.5	0	20.7	38.9	3.1	18.6	.....

The best varieties in the kafir group take third place in grain production under Panhandle conditions. Dawn (dwarf) kafir and Sunrise kafir lead with average yields of 17.9 and 17.5 bushels, respectively, in the 7-year period. Dawn kafir, with an average acre yield of 18.8 bushels in the 9-year period, leads by more than 1 bushel over its nearest competitor. The kafirs have a higher value as combined grain and fodder crops than any other grain sorghums. In actual

farm value, therefore, Dawn kafir and Sunrise kafir should be given second place, taking precedence over milo and feterita. Figure 13 shows graphically the annual and average yields of Blackhull kafir, Dawn kafir, and Red kafir in the 9-year period from 1908 to 1916, inclusive, at Amarillo, Tex.

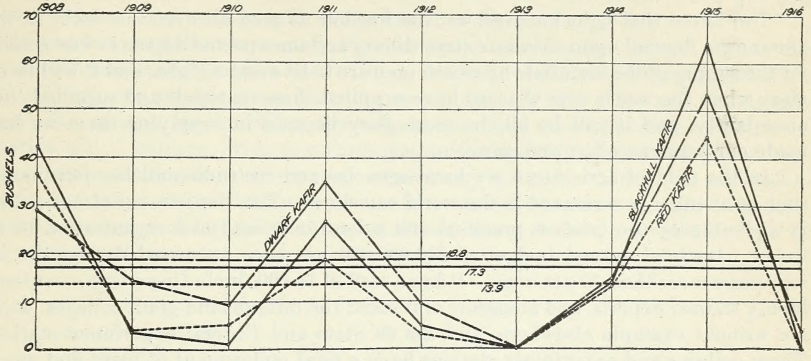

FIG. 13.—Diagram showing the annual and average acre yields, in 60-pound bushels, of Blackhull kafir, Dawn (dwarf) kafir, and Red kafir at the Amarillo Cereal Field Station during the 9-year period from 1908 to 1916, inclusive.

CONCLUSIONS.

The data presented in this bulletin warrant the following conclusions:

(1) Many varieties produce well in favorable seasons. Only well-adapted varieties produce well in the less favorable and unfavorable seasons, which comprise about three-quarters of the total number.

(2) Earliness is the most important single factor in the varietal adaptation of grain-sorghum crops to the conditions obtaining in the high plains of the Texas Panhandle.

(3) Dwarfness is the next most important factor in the adaptation of these crops.

(4) The combination of earliness and dwarfness is extremely efficient in insuring adaptation to environmental conditions which include frequent periods of drought.

(5) Dwarf milo, Dawn (dwarf) kafir, and Sunrise (early) kafir are shown to be well-adapted varieties.

(6) Dwarf milo and Dawn kafir are meeting with wide approval on the farms of the high, dry plains.

(7) Germination and stand are governed largely by local conditions at sowing time.

(8) Tillering, or the production of suckers, is a varietal or group character to some extent. In part it is correlated with stand and seasonal conditions.

(9) The production of erect heads is largely a group or varietal character, but is influenced by the same factors as tillering.

THE PRESIDENT TO THE FARMERS OF AMERICA.

[Extracts from President Wilson's message to the Farmers' Conference at Urbana, Ill., Jan. 31, 1918.]

"The forces that fight for freedom, the freedom of men all over the world as well as our own, depend upon us in an extraordinary and unexpected degree for sustenance, for the supply of the materials by which men are to live and to fight, and it will be our glory when the war is over that we have supplied those materials and supplied them abundantly, and it will be all the more glory because in supplying them we have made our supreme effort and sacrifice.

"In the field of agriculture we have agencies and instrumentalities, fortunately, such as no other government in the world can show. The Department of Agriculture is undoubtedly the greatest practical and scientific agricultural organization in the world. Its total annual budget of $46,000,000 has been increased during the last four years more than 72 per cent. It has a staff of 18,000, including a large number of highly trained experts, and alongside of it stand the unique land-grant colleges, which are without example elsewhere, and the 69 State and Federal experiment stations. These colleges and experiment stations have a total endowment of plant and equipment of $172,000,000 and an income of more than $35,000,000, with 10,271 teachers, a resident student body of 125,000, and a vast additional number receiving instruction at their homes. County agents, joint officers of the Department of Agriculture and of the colleges, are everywhere cooperating with the farmers and assisting them. The number of extension workers under the Smith-Lever Act and under the recent emergency legislation has grown to 5,500 men and women working regularly in the various communities and taking to the farmer the latest scientific and practical information. Alongside these great public agencies stand the very effective voluntary organizations among the farmers themselves which are more and more learning the best methods of cooperation and the best methods of putting to practical use the assistance derived from governmental sources. The banking legislation of the last two or three years has given the farmers access to the great lendable capital of the country, and it has become the duty both of the men in charge of the Federal-reserve banking system and of the farm-loan banking system to see to it that the farmers obtain the credit, both short term and long term, to which they are entitled not only, but which it is imperatively necessary should be extended to them if the present tasks of the country are to be adequately performed. Both by direct purchase of nitrates and by the establishment of plants to produce nitrates, the Government is doing its utmost to assist in the problem of fertilization. The Department of Agriculture and other agencies are actively assisting the farmers to locate, safeguard, and secure at cost an adequate supply of sound seed.

"The farmers of this country are as efficient as any other farmers in the world. They do not produce more per acre than the farmers in Europe. It is not necessary that they should do so. It would perhaps be bad economy for them to attempt it. But they do produce by two to three or four times more per man, per unit of labor and capital, than the farmers of any European country. They are more alert and use more labor-saving devices than any other farmers in the world. And their response to the demands of the present emergency has been in every way remarkable. Last spring [1917] their planting exceeded by 12,000,000 acres the largest planting of any previous year, and the yields from the crops were record-breaking yields. In the fall of 1917 a wheat acreage of 42,170,000 was planted, which was 1,000,000 larger than for any preceding year, 3,000,000 greater than the next largest, and 7,000,000 greater than the preceding five-year average.

"But I ought to say to you that it is not only necessary that these achievements should be repeated, but that they should be exceeded. I know what this advice involves. It involves not only labor, but sacrifice, the painstaking application of every bit of scientific knowledge and every tested practice that is available. It means the utmost economy, even to the point where the pinch comes. It means the kind of concentration and self-sacrifice which is involved in the field of battle itself, where the object always looms greater than the individual. And yet the Government will help and help in every way that is possible.

"It was farmers from whom came the first shots at Lexington, that set aflame the Revolution that made America free. I hope and believe that the farmers of America will willingly and conspicuously stand by to win this war also. The toil, the intelligence, the energy, the foresight, the self-sacrifice, and devotion of the farmers of America will, I believe, bring to a triumphant conclusion this great last war for the emancipation of men from the control of arbitrary government and the selfishness of class legislation and control, and then, when the end has come, we may look each other in the face and be glad that we are Americans and have had the privilege to play such a part."

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